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# GOLD MINING AND MILLING IN THE BLACK CANYON AREA, YAVAPAI COUNTY, ARIZ.

BY

JOS. R. GUITERAS

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DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

# GOLD MINING AND MILLING IN THE BLACK CANYON AREA, YAVAPAI COUNTY, ARIZ.[1]

- - - - - -

By Jos. R. Guiteras[2]

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2/ Mining engineer, mining division, metal mining methods section, U.S. Bureau of Mines.



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## INTRODUCTION

This paper has been written to describe briefly the mining and milling of gold and silver ores in the Black Canyon and neighboring mining districts in Yavapai County, Ariz. The description of present operations is the result of a 10-day visit to the region by the writer in March 1936.

### Acknowledgments

The author is indebted to earlier writers on the geology and mining in this region and to the mine managers and their staffs, whose courteous cooperation has made possible the assembling of material for this paper. Individual acknowledgments are made in the text.

In 1926 the U. S. Geological Survey published, as Bulletin 782, Ore Deposits of the Jerome and Bradshaw Mountains Quadrangles, Ariz., by Waldemar Lindgren. That publication has been followed as a text and widely quoted by subsequent writers on the geology of the Black Canyon country and is recommended to those desiring to understand the geology and history of early mining in the area.



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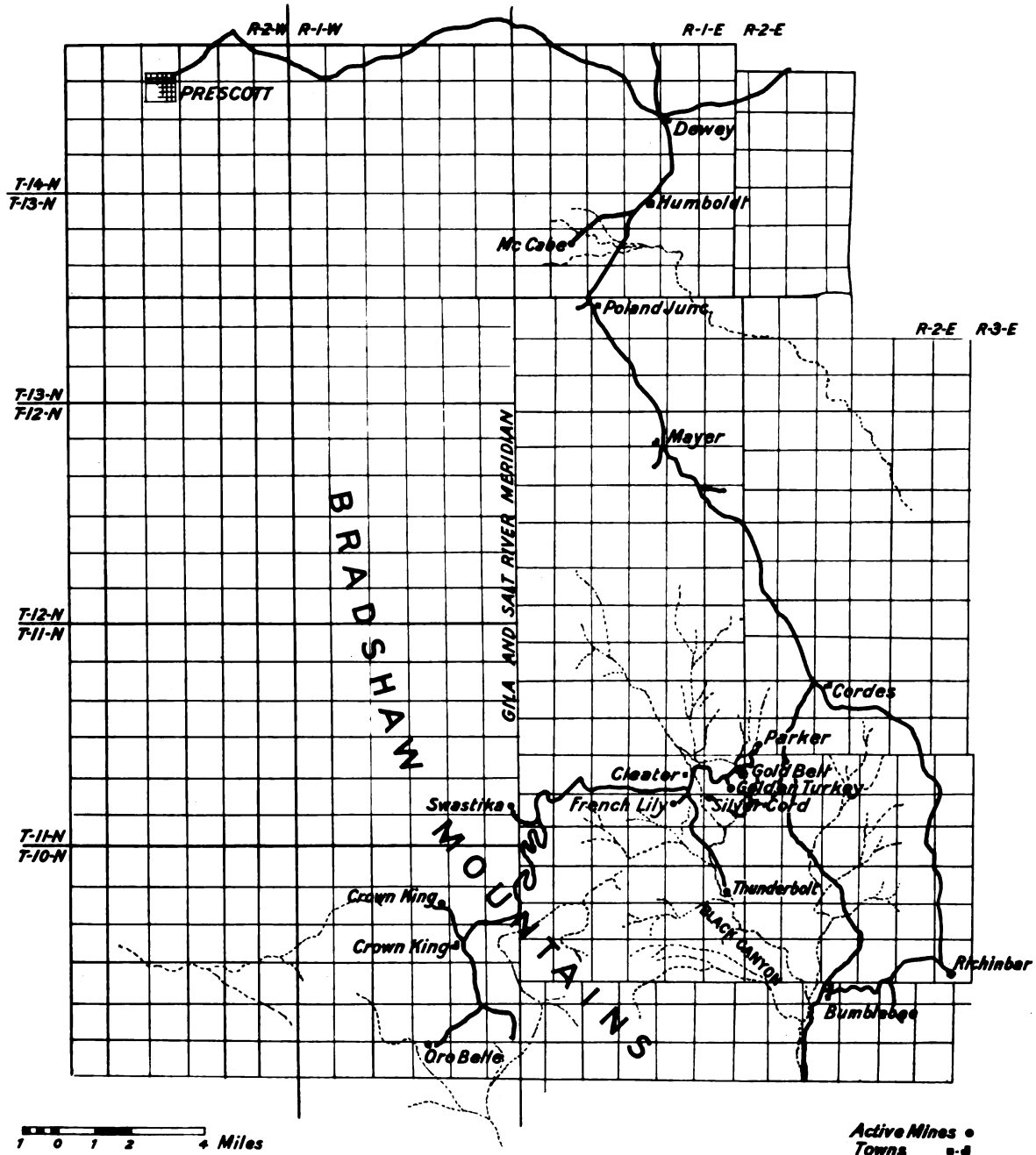


FIGURE 1.– Map of the Black Canyon Region.

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The Arizona Bureau of Mines in 1934 summarized the geology and mining developments in the mining districts of Arizona in Bulletin 6, vol. V, Arizona Lode Gold Mines and Gold Mining, by E. D. Wilson, J. B. Cunningham, and G. M. Butler. The reader is referred to that bulletin for information on gold mining in Arizona.

The tables of ore production were kindly furnished by the Arizona Bureau of Mines from the manuscript of its forthcoming Bulletin 140, Arizona Metal Production, by M. J. Elsing and R. S. Heineman.

## History[3/]

Gold was discovered in the Bradshaw Mountains in 1863. The first mining in the region was done in 1875. The ore was at first shipped to Swansea, Wales, by way of the Colorado River and the Gulf of California. The Southern Pacific and Atchison, Topeka & Santa Fe Railroads were built in 1881, and ore shipments were then made to Denver and San Francisco. Many small mills were built. Pan amalgamation and plate amalgamation were followed by the cyanide and flotation processes. Smelters were located at many places, but most of them were failures. Many of the rich, oxidized ore bodies were worked out in a few years, but activity continued to about 1905. At that time a gradual decline set in. Mining has since been active in various parts of the region and is now experiencing renewed activity under the stimulus of relatively high prices for gold and silver.

## Climate

The area is in the Rocky Mountain region, just beyond the border of the "arid Southwest." Summers are hot, the temperature often reaching 110°, although the mean for June, July, and August is not much above 80°. Winters are mild, with a temperature range between 20° and 75° and a mean of about 50°. Spring and fall temperatures rarely rise above 95° or fall much below freezing; the mean temperature at these seasons is about 55°. Annual precipitation amounts to 18 inches, about one-third of which occurs during July, August, and September. Most of the remainder occurs from December to April. Precipitation during May and June combined usually is less than 1 inch. Virtually no snow falls at elevations below 5,000 feet.

## BLACK CANYON DISTRICT

The Black Canyon mining district is not very well defined but is generally considered to embrace a deeply dissected valley area extending some 25 miles north and south and about 8 miles east and west, which lies just below the eastern foothills of the Bradshaw Mountains. The town of Cleator, formerly Turkey Creek Station, is located within the district. Mayer, a station on the Atchison, Topeka, & Santa Fe Railroad, is the shipping point by rail. Figure 1 shows the location of the district with respect to Prescott, Ariz., the nearest large town. The roads into the district from Prescott and Phoenix are fairly good and are being improved.

A belt of Yavapai schist 2 miles wide lies between the granite mass of the Bradshaw Mountains on the west and an irregular area of lava flows on the east.

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3/ Lindgren, Waldemar, Ore Deposits of the Jerome and Bradshaw Mountains Quadrangles: U. S. Geol. Survey Bull. 782, 1926, pp. 2-3.



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The mineral deposits, according to Lindgren[4/], consist of (1) a series of pyritic lenses in the schist; (2) pre-Cambrian magnetite deposits in schist; (3) pre-Cambrian quartz veins; (4) many flat veins of the younger type apparently connected with dikes of rhyolite porphyry and carrying either silver or gold or both in quartz gangue; and (5) placer deposits. J. P. Cleator, postmaster in the town of that name, states that the only placer mining in the district is being done 3 or 4 miles north of the town, where a few men have started sluicing operations on Turkey Creek.

Table 1 shows the amount and value of the metal production of the Black Canyon district from 1904 to 1933. Table 2 shows the production of the district by mines. Since some of the mines in the district are credited in table 2 with production made prior to 1904, no attempt should be made to reconcile the totals in the two tables.

4/ Lindgren, Waldemar, Ore Deposits of the Jerome and Bradshaw Mountains Quadrangles: U. S. Geol. Survey Bull. 782, 1926, p. 153.



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TABLE 1. - Production of Black Canyon district, Yavapai County, 1904-33[1/]

| Year | Producers | | Tons | Gold value | Silver, ounces | Copper, pounds | Lead, pounds | Zinc, pounds | Total value |
|---|---|---|---|---|---|---|---|---|---|
| | Lode | Placer | | | | | | | |
| 1904 | .... | ..... | 667 | $ 10,460 | 2 | ..... | ..... | ..... | $ 10,461 |
| 1905 | .... | ..... | 4,016 | 20,672 | 162 | ..... | ..... | ..... | 20,770 |
| 1906 | .... | ..... | 2,157 | 22,908 | 540 | ..... | ..... | ..... | 23,275 |
| 1907 | .... | ..... | 1,548 | 3,350 | 112 | 29 | ..... | ..... | 3,430 |
| 1908 | 4 | ..... | 268 | 3,899 | 463 | ..... | 6,288 | ..... | 4,407 |
| 1909 | 1 | ..... | 26 | 35 | 2 | ..... | 3,120 | ..... | 170 |
| 1910 | 1 | ..... | 69 | 1,748 | 2,930 | 61 | 12,808 | ..... | 3,901 |
| 1911 | 2 | ..... | 191 | 2,606 | 7,448 | 319 | 33,667 | ..... | 8,108 |
| 1912 | 3 | ..... | 224 | 924 | 11,096 | 1,092 | 25,258 | ..... | 9,065 |
| 1913 | 3 | ..... | 61 | 184 | 5,700 | ..... | 8,258 | ..... | 3,990 |
| 1914 | 2 | ..... | 27 | 417 | 870 | ..... | ..... | ..... | 898 |
| 1915 | 1 | ..... | 2 | 103 | 2 | ..... | ..... | ..... | 104 |
| 1916 | .... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 1917 | 2 | ..... | 10 | 68 | 91 | 918 | 295 | ..... | 420 |
| 1918 | 2 | ..... | 94 | 333 | 7,583 | ..... | 10,332 | ..... | 8,650 |
| 1919 | 2 | ..... | 142 | 124 | 5,496 | 609 | 3,979 | ..... | 6,603 |
| 1920 | 2 | ..... | 109 | 45 | 5,544 | 264 | ..... | ..... | 6,138 |
| 1921 | 4 | ..... | 93 | 703 | 9,074 | 139 | 12,273 | ..... | 10,347 |
| 1922 | 7 | ..... | 129 | 1,130 | 4,619 | 383 | ..... | ..... | 5,801 |
| 1923 | 4 | ..... | 71 | 879 | 937 | 2,936 | ..... | ..... | 2,079 |
| 1924 | 4 | ..... | 161 | 550 | 3,945 | 274 | ..... | ..... | 3,231 |
| 1925 | 4 | ..... | 208 | ..... | ..... | ..... | ..... | ..... | 9,202 |
| 1926 | 2 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 1927 | 1 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 1928 | 3 | ..... | 200 | ..... | ..... | ..... | ..... | ..... | ..... |
| 1929 | 5 | ..... | 158 | 784 | 1,250 | 5,282 | 536 | ..... | 2,414 |
| 1930 | 6 | ..... | 114 | 1,383 | 1,420 | 1,217 | 5,485 | ..... | 2,362 |
| 1931 | 4 | 1 | 1,581 | 8,693 | 4,369 | 1,514 | 2,397 | ..... | 10,168 |
| 1932 | 12 | 2 | 3,718 | 26,094 | 10,298 | 5,206 | 47,467 | ..... | 30,750 |
| 1933 | 7 | 4 | 6,558 | 40,724 | 27,520 | 6,922 | 162,730 | ..... | 56,820 |
| Total | .... | ..... | 22,602 | 148,816 | 111,476 | 26,965 | 334,893 | ..... | 243,564 |

1/ Elsing, M. J., and Heineman, R. S., Arizona Metal Production: Arizona Bureau of Mines Bull. 140, 1936, p. 82.

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TABLE 2. - Production of Black Canyon district, by mines[1/]

| | Copper, pounds | Lead, pounds | Gold, value | Silver, value | Total, value |
|---|---|---|---|---|---|
| Gillespie, early | ..... | ..... | $ 80,000 | ..... | $ 80,000 |
| Richinbar, 1905-8... | ..... | ..... | 50,000 | $ 10,000 | 60,000 |
| Hidden Treasure .... | ..... | ..... | 20,000 | ..... | 20,000 |
| American Flag ..... | ..... | ..... | 10,000 | 10,000 | 20,000 |
| Old Brooks ..... | ..... | ..... | 10,000 | 10,000 | 20,000 |
| Golden Belt, 1931-33 | ..... | 175,000 | 65,000 | 10,000 | 80,000 |
| Total ..... | ..... | 175,000 | 235,000 | 40,000 | 280,000 |

1/ Elsing, M. J., and Heineman, R. S., Arizona Metal Production: Arizona Bureau of Mines Bull. 140, 1936, p. 102.

## Golden Belt

The Golden Belt mine is on the west bank of Turkey Creek about 2 miles east of Cleator at an altitude of 3,100 feet. It is reached by the new Crown King road, which turns west from the Black Canyon highway 3 miles south of Cordes. The mine is 2-1/2 miles west of the junction. The property, comprising about 15 claims, is operated by Golden Belt Mines, Inc. The original location was made in 1873, and the present operators obtained control in 1931.

The writer is especially indebted to A. L. Lampton, president of the company and general manager at the mine, for his friendly assistance. In 1933 D. C. Minton, Jr., described the Golden Belt mine in Bureau of Mines Information Circular 6735, Cost of Equipping and Developing a Small Gold Mine in the Bradshaw Mountains Quadrangle, Yavapai County, Ariz. Much of his material has been used.

The predominant rock is Yavapai schist, and this is cut in many places by dikes of diorite. The cleavage planes of the schist strike north; the dip is nearly vertical.

The ore is a mixture of pyrite and galena, occurring in thin seams and to some extent disseminated through quartz veins that cut both the schist and the diorite. In some places there is a simple, well-defined vein from a few inches to a foot wide, carrying the sulphide minerals; in other places the quartz vein apparently has split into a number of thin stringers, sometimes comprising a zone as wide as 6 feet. The gold is considered to be with the galena; rocks with pyrite alone are discarded.

At the mine entrance, at the head of the main incline, is the hoist house containing a small tugger hoist driven by a 10-horsepower variable-speed motor. A new hoist has been purchased and will be installed soon. The present hoisting is done with about 1,200 feet of 3/8-inch rope. A 9- by 8-inch compressor, which is in the hoist house, delivers air at 115 pounds pressure to a 4- by 10-foot receiver just outside the building. Air enters the mine through a 1-1/2-inch main airline, which is reduced to 1 inch at working places. The blacksmith



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shop is equipped with a drill sharpener and an oil-burning steel-heating furnace. The drill sharpener and a machine drill underground are operated by air during the day shift, and two drills are operated at night.

The camp contains eight 14- by 20-foot houses occupied by families who pay $5 per month rent. The 12 single men employed are accommodated in four 12- by 14-foot houses and are not charged rent. The company furnishes excellent board for $1 per day. Other buildings in the little settlement include the manager's house, a combined dining room and kitchen, the cook's house, and a wash house with showers. Only American labor is employed at the mine; preference is given to married men.

Water for the camp, including that for drinking and for the mill, is pumped from the mine sump, which is near the lowest part of the underground workings, into the main supply tank above the hoist house. Two 6- by 6-inch triplex pumps, each driven by a 7-1/2 horsepower motor, are located at the sump but only one is operated at a time. When the mine makes more water than one pump can handle, a centrifugal pump driven by a 5-horsepower motor lifts the excess water out of the mine through a churndrill hole. The triplex pumps have a 2-1/2-inch suction pipe and 2-1/2-inch discharge pipes; the centrifugal pump is equipped with a 2-inch suction pipe and a 1-1/2-inch discharge pipe.

There are three air drills on the property, two pluggers, and one light drifter. Where the vein cuts through diorite it is usually narrow and a 4-foot column is used; otherwise a 5- or a 6-foot column may be employed. The drill steel used is 7/8-inch hollow hexagon. Starting with a 2-1/2-inch bit, five lengths of steel are used to drill 7-foot holes, finishing with a 1-5/8-inch bit.

Power for operating the property is brought in at 11,000 volts and is stepped down to 440 volts for all machinery and to 110 volts for lighting purposes. The average monthly cost of power is $750 and is distributed as shown below.

Distribution of power cost

| | Cost per month | Cost per day | Percent |
|---|---|---|---|
| Mine ..... | $ 262.50 | $ 8.75 | 35 |
| Mill ..... | 450.00 | 15.00 | 60 |
| Lighting ..... | 37.50 | 1.25 | 5 |
| | 750.00 | 25.00 | 100 |

The company pays for an average of 80 kw. demand, which is the mean of the highest three peaks during a month. Payment is made on a sliding scale, as follows:

First 100 hours at $0.025 per kw.-hr.
Second 100 hours at $0.02 per kw.-hr.
Third 100 hours at $0.0125 per kw.-hr.
Balance (over 300 hours) at $0.01 per kw.-hr.



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To the sum of these is added the total demand charge, making the average cost of power about 2 cents per kw.-hr.

## Mine

The main incline follows the vein on its undulating dip, which ranges from 10 to 20°. It is about 6 by 8 feet in section and is timbered with 8- by 8-inch drift sets through the loose rock near the surface. After solid rock is reached virtually no timber is used. The incline is used for a haulageway and a manway and carries the air and water pipes. It is electrically lighted. At intervals of about 100 feet drifts are driven both ways along the strike. Inasmuch as the dip of the vein changes frequently, the drifts are not very straight but roughly follow the ore. The present practice is to drive the drifts slightly downgrade so as not to introduce any reverse dips into the rope-haulage system. The drifts are widened immediately up the dip and become a part of the stope that continues to follow the ore in a general direction away from the incline.

No other development openings are being carried ahead of mining operations. There are two air shafts - one on each side of the main incline. The workings are shown in figure 2.

The ore is mined in open stopes, the work progressing locally in a direction up the dip. The ground apparently stands well, and an occasional 8- by 8-inch stull with headboard is the only timbering used. Pillars of ore are left where they are considered necessary for roof support; such pillars probably comprise 2 to 10 percent of the stope area.

One miner breaks the ore in each stope; 12 to 18 holes 7 feet deep are drilled per shift with a light mounted machine. Water for drilling is supplied through a 3/4-inch pipeline tapped into the pump discharge. The holes are loaded with three to five sticks of 40-percent special low-freezing gelatin dynamite. A round of holes breaks about 20 tons.

The vein or veins of ore commonly occupy 6 inches to 3 feet of the 6-foot width usually broken. Large pieces of waste that can be thrown to one side are left in the mine. The broken ore is shoveled into a 16-cubic foot car holding 1,500 pounds, which is brought as near to the working place as tracks can be laid. The car is not detached from the end of the haulage cable unless it is necessary to do so to load it. After being loaded the car is hauled out of the drift and up the incline by the cable to a spring switch just above the hoist, a total distance of 1,000 to 1,200 feet; then it is lowered to the top of the mill, a distance of about 200 feet. A man from the mill picking belt comes up a short flight of steps and dumps the car into the mill hopper. A round trip of the car takes about 5 minutes. All of the ore is transferred from the mine to the mill by this same 1,500-pound car. The ore broken by a round is usually hauled out of a stope in 4 hours. Bottom rollers for the cable are used along the incline, and side rollers are used at turns from the incline into the several drifts. Tracks are of 12-pound rail.

During the first 22 days of February 1936 an average of 73 cars of ore was hoisted per day; 24.5 cars of waste was sorted out on the picking belt at the



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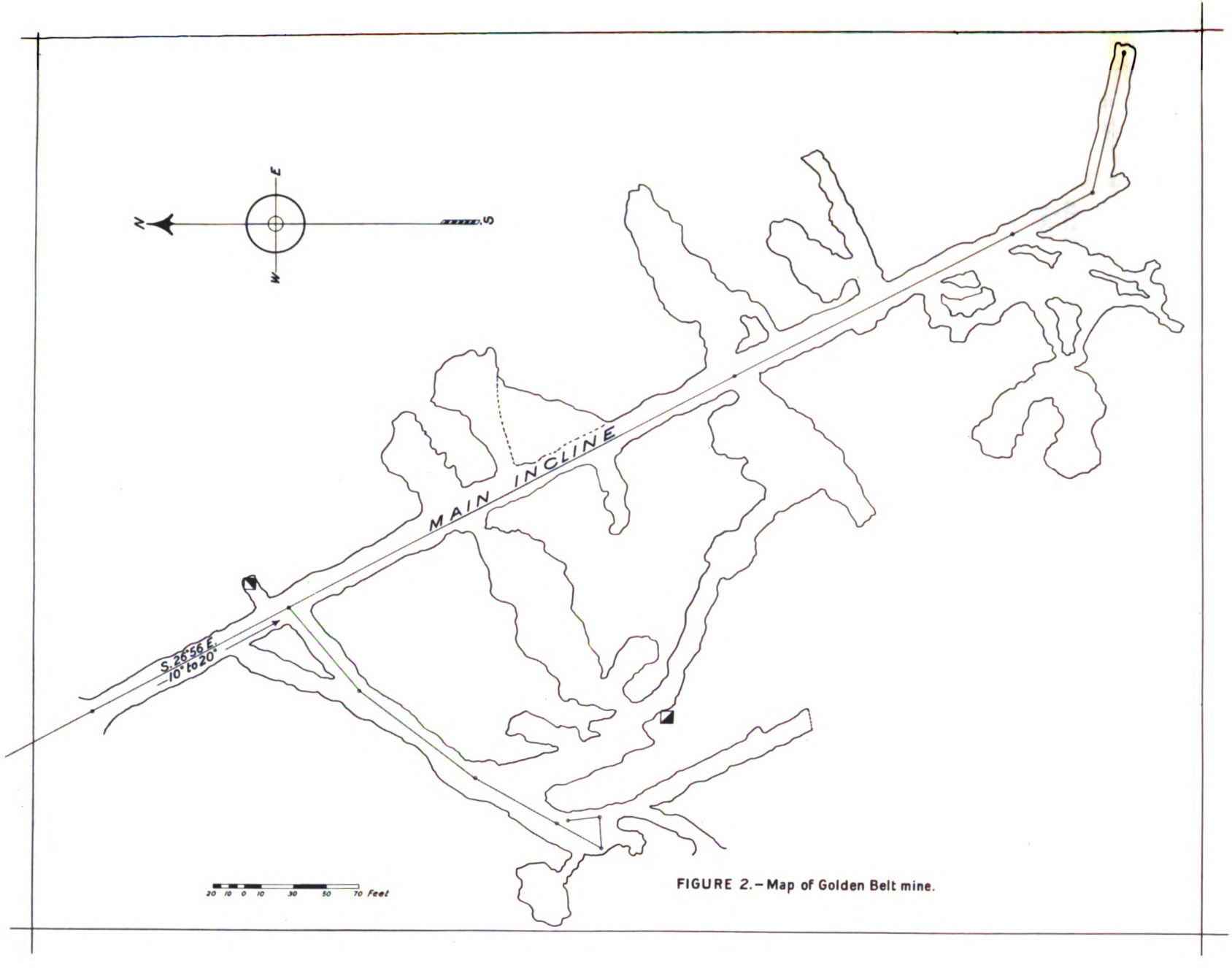


FIGURE 2.—Map of Golden Belt mine.

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head end of the mill, leaving 48.5 cars, or two-thirds of the ore hoisted, to go through the mill.

During January 1936 a total of 1,973 cars of ore was delivered to the mill; 1,973 cars at 1,500 pounds = 1,480 tons, or an average of 47.7 tons of ore per day. In that month 190 cars of waste were thrown over the dump.

Two 8-hour shifts per day were worked in the mine and three in the mill. The pay roll is about $100 per day for an average of 27 men employed and is made up as follows:

Daily pay roll

| Occupation | Number | Wage, rate | Cost per day | Totals |
|---|---|---|---|---|
| Surface: | | | | |
| Cook ..... | 1 | $4.00 per day .... | $ 4.00 | $ 4.00 |
| Mine: | | | | |
| Foreman ..... | 1 | $180.00 per month | 6.00 | |
| Blacksmith ..... | 1 | $170.00 per month | 5.67 | |
| Hoistmen ..... | 2 | $4.00 per day .... | 8.00 | |
| Machinemen ..... | 3 | $130.00 per month | 13.00 | |
| Muckers ..... | 11 | $100.00 per month | 36.67 | 69.34 |
| Mill: | | | | |
| Millmen, one of whom is mill superintendent ..... | 3 | $4.00 per day .... | 12.00 | |
| Head ore sorters ... | 2 | $100.00 per month | 6.67 | |
| Assistant ore sorters | 2 | $70.00 per month | 4.67 | ..... |
| General utility man | 1 | $4.00 per day .... | 4.00 | 27.34 |
| Totals, per day ..... | 27 | ..... | ..... | $100.68 |

Cost of mine supplies for January 1936

| Item | Reported used | Calculation | Cost |
|---|---|---|---|
| Powder ..... | 6,339 sticks ..... | 112 sticks to a 50-pound box; 2,830 pounds at $12.75 per 100 pounds. | $360.83 |
| Blasting caps. | 1,156 ..... | At $17.25 per 1,000 ..... | 19.94 |
| Fuse ..... | (1,156 x 6 = 6,936) | At $8.15 per 1,000 ..... | 56.53 |
| Carbide ..... | 4 cans .....1.. | 400 pounds at $6.85 per 100 ... | 27.40 |
| Compressor oil | 21 gallons ..... | At 49-1/2 cents per gallon .... | 10.40 |
| Machine oil .. | 21 gallons ..... | At 49-1/2 cents per gallon .... | 10.40 |
| Drill steel .. | 20 pieces ..... | 20 pieces, 7 feet long, 2-¼ pounds per foot; 315 pounds at $15.50 per 100 pounds. | 48.83 |
| Timber ..... | 4 - 8 by 8 by 16 .. | 1 - 8 by 8 by 16 timber per week; 341.33 board feet at $32.50 per 1,000 board feet. | 11.09 |
| Total cost of mine supplies for January ..... | | | 545.42 |
| Average cost per day ..... | | | 17.59 |



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Mine operating costs, Based on January 1936 Production:
(47.7 tons of ore and 3.3 tons of concentrates per day)

| | Percent | Cost per day | Cost per ton of ore | Cost per ton of concentrates |
|---|---|---|---|---|
| Labor ..... | 73 | $ 69.34 | $ 1.45 | $ 21.01 |
| Supplies ..... | 18 | 17.59 | .37 | 5.33 |
| Power ..... | 9 | 8.75 | .18 | 2.65 |
| | 100 | 95.68 | 2.00 | 28.99 |

## Mill

The Golden Belt mill is rated at 50 tons of ore per 24 hours. The building is made of wood and is on the side of a hill; elevating of material is not necessary. Concentration is effected by flotation, the usual ratio of concentration being 13-15 to 1. About 100 tons of concentrates are made per month. Attempts were made early to cyanide the ore but were abandoned due to difficulty experienced in dissolving the gold.

The flow sheet of the mill is shown in figure 3. The ore sorter, after dumping the mine car, returns to the picking belt, starts the motor, and opens the discharge gate of the hopper. The picking belt, which is 16 inches wide and about 10 feet long, travels at the rate of 21 feet per minute. The sorter and his helper pick out the large pieces of waste and throw them into a small mine car, which is dumped to waste when filled. About one-third of the material hoisted is thus sorted; the sorting requires about 5 minutes per car of ore. The conveyor belt delivers the picked ore to a 7- by 10-inch Blake-type jaw crusher, which runs continuously when the mine is operating. When crushing dry ore the jaws are set at 1 inch; on wet ore the discharge is widened to 1-1/2 inches. The grizzly formerly used ahead of the crusher has been abandoned. The crushed product drops into a 35-ton ore bin. A 30-inch Challenge feeder at the bottom of the bin delivers the ore to a launder leading to a 4- by 5-foot cylindrical ball mill. Water is added to the ore in the launder. The flotation reagents are added to the ball-mill feed as follows:

Sodium xanthates, Z-5 and 301, 5-percent solution, about 45 drops per minute, 1 gallon per 10 hours.

Pine oil, 30 drops per minute, 1 gallon per 12 hours.

The cost of reagents is estimated at 1-1/2 cents per ton of ore. Four-inch cast-iron balls are used for grinding, the ball consumption being estimated at 2 pounds of balls per ton of ore ground. A 6- by 20-foot duplex drag classifier is in closed circuit with the ball mill. The overflow from the classifier, containing minus 48-mesh material, is conducted by launders to a 4-cell flotation machine of 50 tons capacity. The first two cells make a finished concentrate. The other two cells make a middling product that is run back to the first cell



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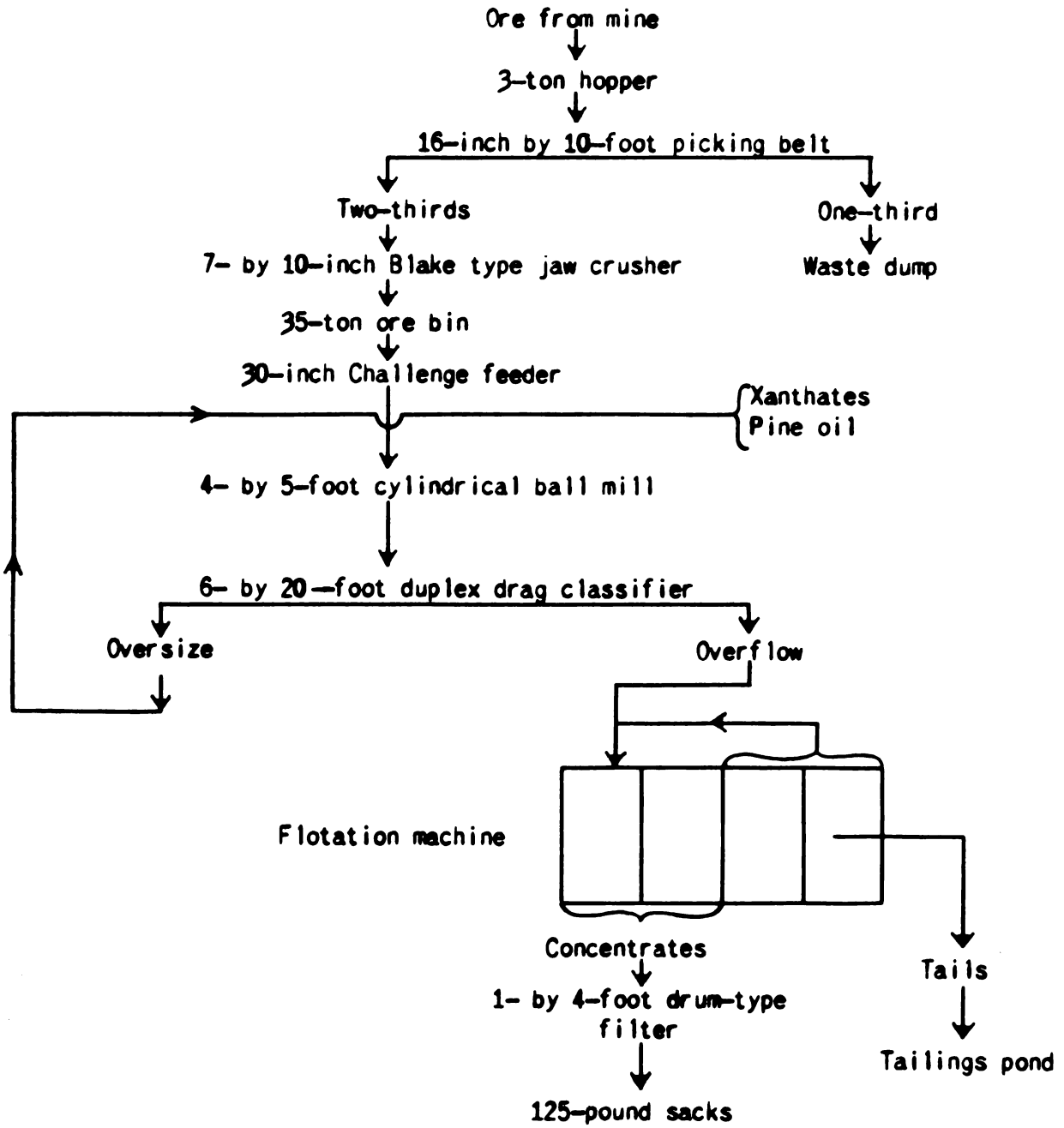


Figure 3.- Flow sheet of Golden Belt mill.

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and a tailing that is run out on the pond through a 2-inch (inside-diameter) wood-stave pipe. A small stream of water breaks up the concentrate froth, which then passes to a 1- by 4-foot, rotary, drum-type filter.

The machines in the mill are driven by independent motors, using V-belt drives, the sizes of motors being as follows:

| | Hp. motor |
|---|---|
| Jaw crusher | 15 |
| Picking belt | 2 |
| Challenge feeder | 1-1/2 |
| Ball mill | 40 |
| Classifier | 5 |
| Flotation machine | Two 3 |
| Filter | 1-1/2 |
| Vacuum pump | 2 |
| Total | 73 |

The concentrates, containing about 8 percent moisture, are scraped off the filter directly into sacks for shipment. The sacks hold about 125 pounds of concentrate, that is, 16 sacks to the ton. About 3-1/4 tons of concentrates are being sacked daily. A trucking company hauls the sacked concentrates to El Paso for $8.15 per ton and returns the empty sacks. Smelter returns indicate that about half of the moisture in the concentrates is lost in transit.

The water consumption of the mill is estimated at 1-1/2 tons of water per ton of ore.

The overflow of the classifier is sampled every hour with a small scoop. Samples for the day are collected and dried and are assayed every week. That is the head sample. The concentrates are sampled by taking an augerful from the center of each sack. No regular sample is taken of the tails. At the present time they are estimated to contain 0.01 ounce of gold and 0.31 ounce of silver per ton. Recent assays of heads are as follows:

| | Gold, ounce per ton | Silver, ounces per ton |
|---|---|---|
| February 19-22, 1936 | 0.24 | 3.26 |
| February 22-24, 1936 | .30 | 5.62 |

These samples contain about 0.5 percent lead.

Assays of concentrates over the same period (February 19-24, 1936) are as follows: Gold, 3.08 ounces per ton; silver, 40.92 ounces per ton; lead, 12.88 percent; value per ton, $139.10.

The value is figured on the basis of gold at $32.81 per ounce, silver at $0.75 per ounce, and lead at $0.60 per unit (20 pounds). Other recent assays are as follows:



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| Date | Item | Assay | | | Gross value |
|---|---|---|---|---|---|
| | | Gold, ounces per ton | Silver, ounces per ton | Lead, percent | |
| Jan. 20, 1936 | Heads ..... | 0.21 | 1.99 | ..... | $ 8.38 |
| Jan. 16-24, 1936 | Concentrates | 2.62 | 19.68 | 14.16 | 107.21 |
| Jan. 20, 1936 | Tails ..... | .01 | .31 | ..... | .56 |

On the basis of these assays the recovery of gold is about 96 percent and of silver 86 percent. Usual recovery, however, is estimated at 95 percent of the gold and 80 percent of the silver.

Recent figures show the following weights of concentrates sacked at the mill:

| | Pounds | Tons |
|---|---|---|
| November 1935 ..... | 221,750 | 111 |
| December 1935 ..... | 248,250 | 124 |
| January 1936 ..... | 204,500 | 102 |

For January 1936 the ratio of concentration was 14.5 to 1.

Monthly cost of mill supplies based on January 1936 production

| Item | Used | Cost |
|---|---|---|
| Cast-iron balls ..... | 2 tons at $32 per ton ..... | $ 64.00 |
| Liners for ball mill ..... | Cost $300; have life of 9 months .. | 33.33 |
| Impellers for flotation machine | 4 impellers at $9.75 = 39.00; have life of 6 months. | 6.50 |
| Filter cloth ..... | ..... | 20.00 |
| Parts for vacuum pump ..... | $10 in three months ..... | 3.33 |
| Flotation reagents ..... | At 1-1/2 cents per ton of ore ..... | 22.20 |
| Lubricants and miscellaneous ... | Estimated ..... | 50.00 |
| Total monthly cost of mill supplies ..... | | $199.36 |
| Average cost per day ..... | | 6.43 |

Mill operating costs based on January 1936 production

(47.7 tons of ore, 3.3 tons of concentrates per day)

| | Percent | Cost per day | Cost per ton of ore | Cost per ton of concentrates |
|---|---|---|---|---|
| Labor ..... | 56 | $ 27.34 | $ 0.57 | $ 8.28 |
| Supplies ..... | 13 | 6.43 | .14 | 1.95 |
| Power ..... | 31 | 15.00 | .31 | 4.55 |
| Totals ..... | 100 | 48.77 | 1.02 | 14.78 |



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Consolidated operating costs per ton of concentrates,

based on January 1936 production

(47.7 tons of ore, 3.3 tons of concentrates per day)

| | Mine | Mill | Total | Percent |
|---|---|---|---|---|
| Labor ..... | $ 21.01 | $ 8.28 | $ 29.29 | 67 |
| Supplies ..... | 5.33 | 1.95 | 7.28 | 17 |
| Power ..... | 2.65 | 4.55 | 7.20 | 16 |
| Totals ..... | 28.99 | 14.78 | 43.77 | 100 |
| Percent ..... | 66 | 34 | 100 | ..... |

These costs obviously omit depreciation, management, and other costs usually included in "overhead."

The smelter treatment charge usually is about $5 per ton, with 50 cents per ton additional for handling the sacks.

A February shipment of 41 tons netted the mining company $83.60 per wet ton after all deductions had been made, including freight. Letails of this shipment follow:

| | |
|---|---|
| No. of sacks ..... | 673 |
| Wet weight ..... | 82,120 |
| Moisture, percent ..... | 4.1 |
| Dry weight ..... | 78,039 |
| Metal quotations: | |
| U. S. silver ..... | $0.77 |
| Lead ..... | .045 |
| Copper ..... | .089 |

| | Assay | Deduct | Net | Pay for - Percent | Pay for - At | Value per ton |
|---|---|---|---|---|---|---|
| Gold ..... | 2.48 ounces | ..... | ..... | 100 | $32.81825 | $81.39 |
| Silver ..... | 21.3 ounces | ..... | ..... | 95 | .755 | 15.28 |
| Lead ..... | 10.6 percent | 1.5 | 9.6 | 95 | .03075 | 5.32 |
| Copper ..... | .52 percent | .4 | .12 | 95 | .03875 | .09 |
| | | | | | | 102.08 |

| | | |
|---|---|---|
| Smelter base rate for values up to $75 per ton ..... | $ 3.20 | |
| 10 percent of excess over $75 (max.) ..... | 1.80 | |
| Handling sacks ..... | .50 | $ 5.50 |
| Net value per ton ..... | | 96.58 |
| Total value of 39.0195 dry tons at $96.58 ..... | | 3,768.50 |
| Less freight on 41.06 wet tons at $8.15 ..... | $334.64 | |
| Less umpire assay ..... | 6.00 | 340.64 |
| Balance due shipper ..... | | $3,427.86 |



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As a matter of policy, the smelter actually withheld from the above net proceeds, pending the receipt of the silver affidavit, the sum of $254.80, representing the difference between the domestic and foreign values of the silver. Inasmuch as operating costs were about $43.77 per ton, as previously shown, a substantial profit is indicated, even after making liberal allowance for overhead.

## Golden Turkey

The private road to the Golden Turkey mine leaves the Crown King road a quarter of a mile south of the Golden Belt road. This mine is on the west side of Turkey Creek at an elevation of about 3,000 feet. The property is about 15 miles south of Mayer, the railway shipping point, and adjoins that of the Golden Belt on the south.

The mine is operated by the Golden Turkey Mining Co., composed of H. C. Mitchell and associates. The company was incorporated under the laws of the State of Illinois on November 14, 1933. About 11 mining claims were purchased in the fall of 1932 under an escrow agreement calling for royalty payments of 10 percent of the net smelter proceeds to apply against the purchase price. To date the property has produced about $200,000; most of the production was in 1935. During that year the company had a net income of $20,315.87, part of which was used to reduce outstanding liabilities and $12,576.28 of which was spent for machinery and additions to structures. The mineral properties, plant, and equipment are given a book value of about $100,000.

The Golden Turkey is working in the same vein as the Golden Belt, which has the same general characteristics in both properties. About 75 tons of gold ore is mined daily and treated in a flotation mill.

The information about the mine contained in this paper was obtained through the courtesy of Mr. Mitchell. Most of the statistical data are from the auditor's report for the fiscal year ended October 31, 1935.

Two compressors, usually used alternately, are housed in the mill building. They are 9- by 8-inch, 3-drill machines, driven through multiple V-belt drives by motors of 25 and 20 horsepower, respectively. They furnish air at 90 pounds per square inch. The blacksmith shop is equipped with the latest type of oil forge and drill sharpener.

Water for domestic purposes and for drilling at the Golden Turkey is pumped from a well near Turkey Creek into a 10- by 18-foot (11,000-gallon) storage tank on the surface. Water for the mill is pumped from the mine. A 3-1/2- by 4-inch electrically driven triplex pump near the bottom of a new shaft, which corresponds to the 900-foot level, lifts the water to a sump on the 700-foot level. When this sump is filled, an automatic float valve starts an electrically driven centrifugal pump with a capacity of 100 gallons per minute, which pumps the water to another sump between the 400- and 600-foot levels. Here it is picked up by a 4- by 6-inch triplex pump, also electrically driven, and delivered through a 2-1/2-inch pipeline to the mill storage tank just above the head of the hoisting incline. This tank is 16 by 18 feet and holds 27,000 gallons of water.



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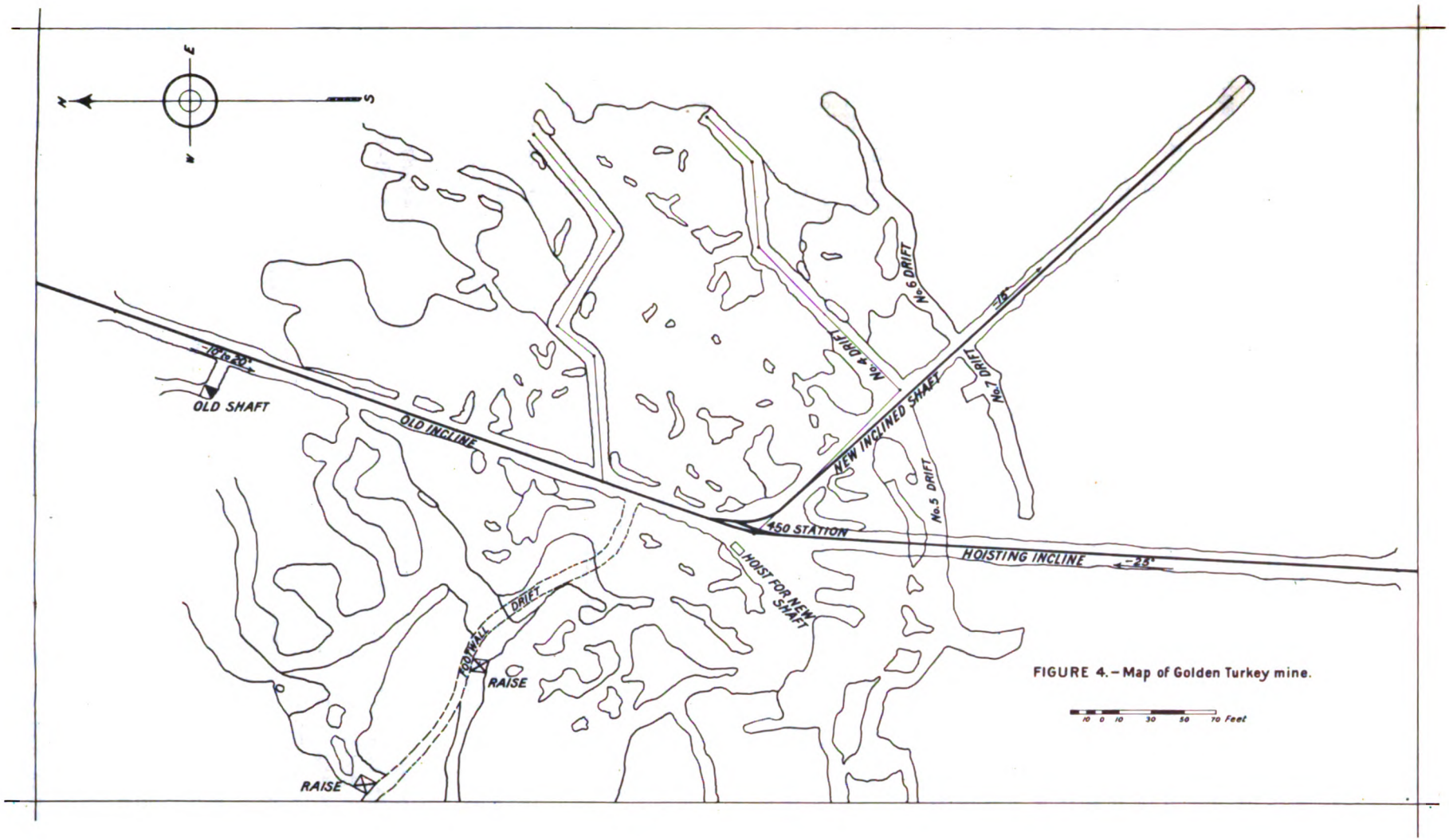


FIGURE 4.—Map of Golden Turkey mine.

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## Mine

The Golden Turkey mine formerly was worked through an incline driven on the vein, but the old incline now serves only as a manway and a haulageway for supplies in addition to its incidental use for ventilation. A map of the underground workings is shown in figure 4.

Hoisting is now done through a 25° incline that crosscuts the formations and intersects the old incline at the 450-foot level. A station at the intersection is provided with tracks for handling loaded cars and empties while hoisting. At the 450-foot station is also a hoist for hauling ore up the new inclined shaft, which is being driven directly down the dip of the vein from this point. Several drifts have been driven from the new shaft, and a number of stopes have been opened up. In the main incline and in the new shaft 25-pound rails are employed. In the mine 12-pound rails are now being used; 8-pound rails formerly were employed in the upper workings. All track is 18-inch gage. A 5/8-inch hoisting cable is used on the surface incline and a 3/8-inch cable in the new shaft.

About 150 tons per 8-hour shift can be hoisted with present facilities. Ore is trammed by hand on the levels, mostly in 20-cubic foot roller-bearing cars, although several 12- and 14-cubic foot cars are still in use in the mine. The cars that are loaded below the 450-foot level are attached to the hoisting cable in the new shaft and transferred at the 450-foot station for hoisting to the surface.

The dip of the ore ranges from zero to nearly vertical locally, although most dips lie between 10 and 20°. The flat dip suggested two methods of attack:

1. To drive crosscuts into the footwall from some centrally located point and then to raise up to the vein at intervals, using the raises to transfer the ore to a haulage level below.

2. To drive an incline directly down the dip and drift both ways at intervals; then to mine by open stopes up the dip. If wheelbarrows were to be used in the stopes for transferring the ore, the drifts should be about 75 feet apart.

The first of these methods was used in one place in the west part of the mine. Two 4- by 6-foot, 2-compartment raises, one 35 feet high and the other 50 feet high, were driven up vertically from a crosscut on the 450-foot level to intersect the vein. The second method is used in the lower workings on both sides of the new shaft. Because it is necessary to shovel the broken ore more than once in many parts of the mine, scrapers and slushers were introduced. They were used in the older workings in the west part of the mine but were abandoned later because they afforded no opportunity to sort out waste. Wheelbarrows are used in flat stopes. They are dumped into the cars.

The ore is mined by breast stoping for a height of about 6 feet. Stulls with headboards are used as required and an occasional pillar is left, mainly along haulageways.

Drilling in stopes and drifts is done with mounted pluggers, two on day shift and one at night, using 7/8-inch hollow hexagon steel. The raises were driven with self-rotating stopers.



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## Mill

The ore is treated in a flotation mill; the concentrate contains 2 to 2.5 ounces of gold and 40 to 50 ounces of silver per ton and is valued at about $100 per ton. Metallurgical tests made before the mill was built indicated that the ore was not amenable to either the cyanide or amalgamation process.

The mill was erected in the fall of 1934 at a cost of $22,000. The building is of steel construction with corrugated-iron sides and roof. It is of the side-hill type, the only elevating of material being from the bottom of the ore bin up to the ball mill. The mill has a rated capacity of 75 tons per 24 hours; the flow sheet is shown in figure 5.

The ore is hoisted from the mine in 1-ton cars that are brought to the top of the incline and then lowered through a spring switch and down a slight grade for about 100 feet to the top of the mill. When a car of ore arrives at the mill, a man from the sorting belt dumps it into a 3-ton hopper. The ore passes from the hopper gate onto a picking belt 16 inches wide and 12 feet long, at which four or five men stand and throw out waste rock. The belt is driven by a 2-horsepower motor through reducing gears and delivers the picked ore to a cantilever-type grizzly having 1-inch spaces between the bars. The oversize passes through a high-speed jaw crusher which makes a 3/8-inch product. The crusher is driven by a 20-horsepower motor with a multiple V-belt drive. The crushed ore joins the undersize from the grizzly in a 130-ton ore bin. The part of the mill so far described is operated only on the day shift, no ore being hoisted from the mine at night.

A 16-inch belt conveyor, 18 feet long and driven by a 2-horsepower motor through a motor-control speed regulator and gears, carries the crushed ore to the ball mill. This mill is of the cylindrical type, 4 by 6 feet, and is driven by a 40-horsepower motor. The grinding balls are of forged steel 3 inches in diameter and are consumed at the rate of about 2 pounds per ton of ore. To the ball-mill feed are added water and 12 to 15 drops per minute of Aerofloat no. 15 and 30 drops per minute of pine oil. The ball mill is run in closed circuit with a 16- by 2-foot drag classifier driven by a 2-horsepower motor.

The overflow from the classifier (minus 40-mesh) enters the second cell of a six-cell flotation machine driven by three 3-horsepower motors. Pine oil is added here at the rate of 15 drops per minute; and xanthate 301, in a 10-percent solution, is added at the rate of 7 pounds per 24 hours. The second and third cells make a finished concentrate. The froth from the last three cells is cleaned in the first cell, and this concentrate is washed with the other into a 6-foot thickener operated by a 1-1/2-horsepower motor. The thickened pulp is filtered on a 2- by 4-foot drum-type filter driven by a 3-horsepower motor, which is operated 4 hours per 24 hours. Another 3-horsepower motor drives the combined vacuum pump and blower for the filter. The concentrates are conveyed in a wheelbarrow to a storage room and are later shoveled through an opening in the floor into a truck.

The overflow from the thickener runs into one of two settling tanks, which are alternately siphoned out and the settlings dried and shipped with the concentrates.



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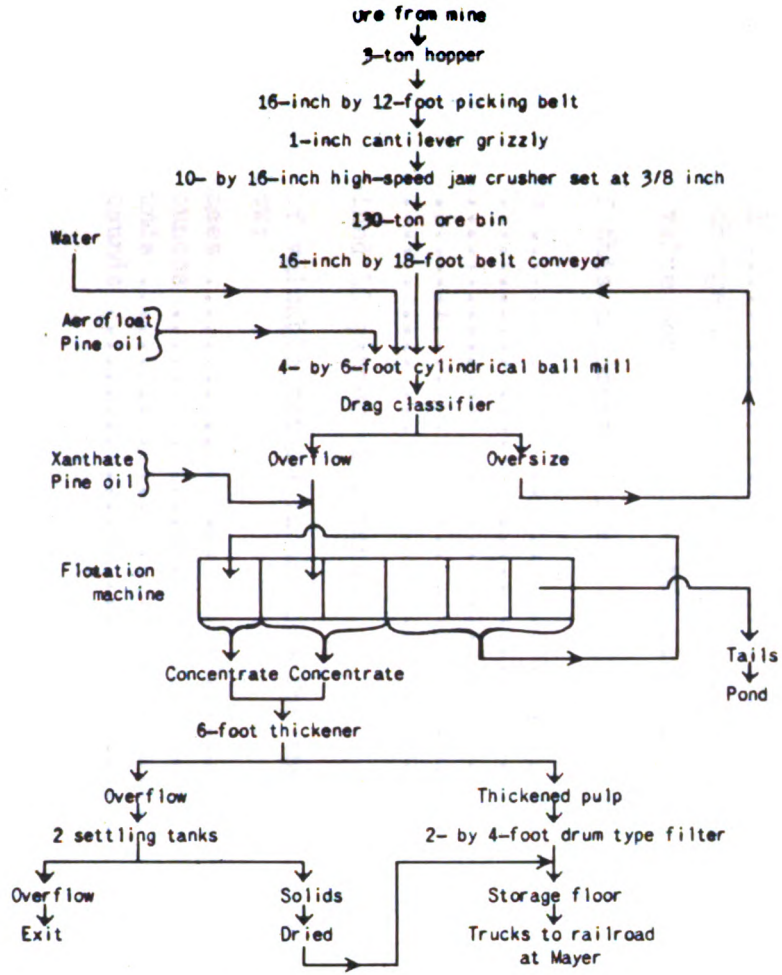


Figure 5.- Flow sheet of Golden Turkey mill.

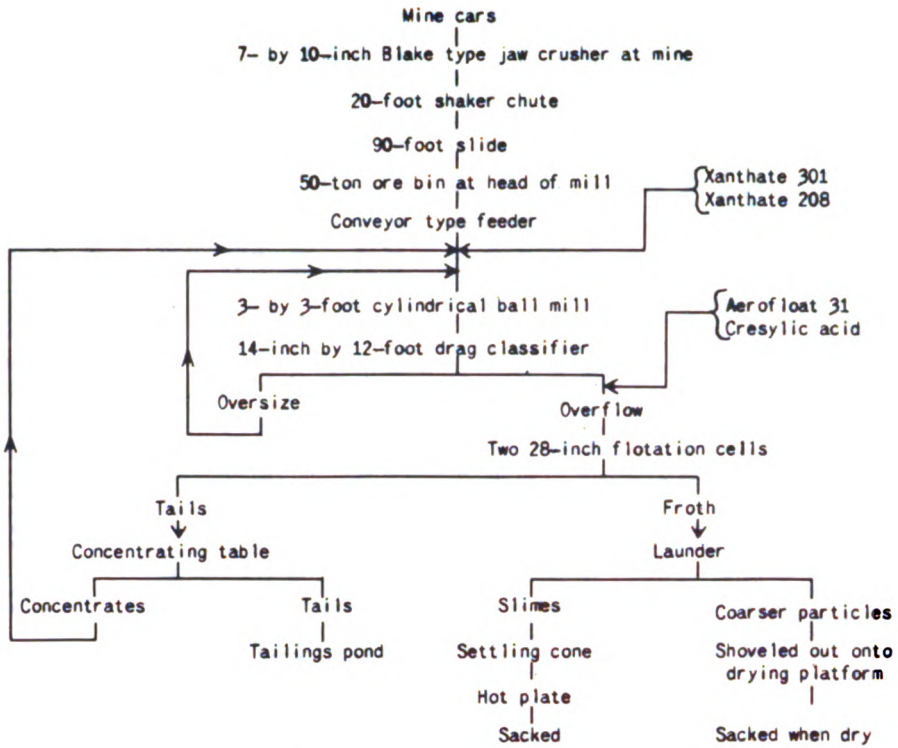


Figure 6.- Flow sheet of Black Canyon mill.

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The company has been using a special unit flotation cell in the circuit with the ball mill and classifier with some degree of success, but it was not in operation at the time of the author's visit. The character of the ore changes somewhat from day to day, and the flow sheet is adjusted to meet conditions. The quantities of flotation reagents used are subject to wide variation, and the figures given here are representative only in connection with the particular characteristics of the ore being treated at the time of the visit.

With the present type of ore, which contains a little oxidized material, the recovery is estimated to be about 90 percent. It is thought that a 95-percent recovery can be made of purely sulphide minerals. Tails are regarded as usually carrying values from 35 cents to $1 per ton, late assays showing 0.01 to 0.02 ounce of gold per ton and 0.60 to 1.00 ounce of silver per ton.

Concentrates are trucked to Mayer 14.5 miles distant for $2 a ton. They are taken out once a week, and the trucking cost includes loading on the cars at Mayer. The freight rate from Mayer to El Paso is based on the net value and is about $7.85 per ton. The concentrates for August and September 1935 returned the following average assays: Gold, 2.10 ounces per ton; silver, 50 ounces per ton; lead, 4.75 percent; value per ton, $110.00.

A shipment of concentrates made in February 1936 showed:

| | Assay | Value |
|---|---|---|
| Gold | 2.53 ounces per ton | $ 83.03 |
| Silver | 39.00 ounces per ton | 27.97 |
| Lead | 7.00 percent | 3.21 |
| Copper | 0.75 percent | .26 |
| Total | | 114.47 |
| Smelting charge | | 5.00 |
| Net value per ton, at smelter | | 109.47 |

An analysis of this shipment follows:

| | Percent |
|---|---|
| Insoluble | 13.8 |
| Iron | 32.3 |
| Zinc | .2 |
| Sulphur | 34.2 |
| Alumina | 1.2 |

The shipment contained 10 percent moisture.

The recovery of valuable metals in the ore for the year ending October 31, 1935, is shown below:

| | |
|---|---|
| Gold, ounces | 2,983 |
| Silver, ounces | 61,956 |
| Lead, pounds | 304,837 |
| Copper, pounds | 17,376 |



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The average recovery of gold was about 2.04 ounces and of silver about 42.4 ounces per ton of dry concentrates. Gold thus accounts for about two-thirds of the total smelter values and silver one third. Forty-three shipments of concentrates were made during the year ended October 31, 1935, summarized as follows:

| | |
|---|---|
| Gross proceeds | $132,959.55 |
| Marketing expense | 12,377.59 |
| Net proceeds | 120,581.96 |
| Dry tons | 1,396,825 |
| Net yield per dry ton | $86.33 |

Corresponding figures for the six shipments of high-grade ore made during the same year were:

| | |
|---|---|
| Gross proceeds | $ 5,296.13 |
| Marketing expense | 917.77 |
| Net proceeds | 4,378.36 |
| Dry tons | 154.53 |
| Net yield per dry ton | 28.39 |

During February 1936 the payroll averaged 40 men, distributed as shown below:

| | Number |
|---|---|
| Mine: | |
| Foreman | 1 |
| Miners and timbermen | 5 |
| Muckers and trammers | 16 |
| Hoistman, underground | 1 |
| Hoistman, surface | 1 |
| Utility men | 2 |
| Total | 26 |
| Mill: | |
| Shiftmen | 3 |
| Crusher floor men | 4 |
| Tailings men | 1 |
| Utility men | 2 |
| Blacksmith | 1 |
| Total | 11 |
| Mess Hall: | |
| Cook | 1 |
| Assistants | 2 |
| Total | 3 |
| Total per day | 40 |

The company operates a boarding house, and the men are paid on the basis of wages plus board. There are no family houses. Both American and Mexican laborers are employed. The wage scale is as follows:



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| | |
|---|---|
| Miners and timbermen | $3.50 per day and board |
| Muckers and trammers | 2.00 per day and board |
| Shaftman | 4.50 per day and board |
| Top hoistman | 90.00 per month and board |
| Underground hoistman | 75.00 per month and board |
| Master mechanic | 120.00 per month and board |
| Blacksmith | 105.00 per month and board |
| Mill men | 120.00 per month and board |

The average cost to the company of board per man per day is $0.85
The average cost to the company of lodging per man per day is .22
Board and lodging per man per day is $1.07

## Production and costs

The daily progress report for February 27, 1936, typical of the present scale of operations, follows:

| 20-cubic foot cars | | | Number of headings | Concentrates, cwt. | Mill hours | Value of concentrates per ton |
|---|---|---|---|---|---|---|
| To mill | To dump | Waste from picking belt | | | | |
| 495 | 163 | 144 | 4 - 5 | 660 | 24 | $ 96.40 |

A summary of production for the fiscal year 1935 shows:

| | |
|---|---|
| Employment, man-hours | 14,000 |
| Waste rock hoisted, tons | 11,911 |
| Ore hoisted and milled, tons | 23,806 |
| Concentrates produced (containing about 8.63 percent moisture), tons (wet) | 1,529 |
| High-grade ore shipped, tons (dry) | 157 |

These figures indicate a ratio of concentration of about 15.6 to 1. They also show that 1 ton of waste was hoisted to every 2 tons of ore.

The cost and results of company operations for the year ended October 31, 1935, follow:

| Item | Total | Percentage | Monthly average | Daily average |
|---|---|---|---|---|
| Sales of ore and concentrates | $138,255.68 | 100.00 | $11,521.31 | $378.78 |
| Operating costs: | | | | |
| Marketing expense | 13,295.36 | 9.62 | 1,107.95 | 36.43 |
| Hauling to Mayer | 3,657.13 | 2.65 | 304.76 | 10.02 |
| Crushing and milling | 29,438.67 | 21.29 | 2,453.23 | 80.65 |
| Mining and hoisting | 44,970.78 | 32.53 | 3,747.56 | 123.22 |
| Cookhouse costs | 11,976.50 | 8.66 | 998.04 | 32.81 |
| Camp maintenance | 3,056.47 | 2.21 | 254.71 | 8.37 |
| Administration | 8,794.55 | 6.36 | 732.88 | 24.09 |
| Total operating costs | 115,189.46 | 83.32 | 9,599.13 | 315.59 |
| Net profit before income taxes | 23,066.22 | 16.68 | 1,922.18 | 63.19 |
| Income taxes | 2,750.35 | 1.99 | 229.19 | 7.53 |
| Net profit to surplus | 20,315.87 | 14.69 | 1,692.99 | 55.66 |

The costs shown in the above table were distributed as follows:



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| Item | Total | Percentage | Monthly average | Daily average |
|---|---|---|---|---|
| Sales of ore and concentrates | $ 138,255.68 | 100.00 | $11,521.31 | $ 378.78 |
| Over-all expenses: | | | | |
| Salaries and wages..... | 40,009.19 | 28.94 | 3,334.12 | 109.61 |
| Supplies consumed ..... | 24,914.84 | 18.02 | 2,076.24 | 68.26 |
| Transportation (rail and truck) ..... | 18,006.19 | 13.02 | 1,500.52 | 49.33 |
| Power ..... | 9,523.44 | 6.89 | 793.62 | 26.09 |
| Depreciation ..... | 6,613.88 | 4.78 | 551.12 | 18.13 |
| Depletion (3/31st of cost). | 4,884.20 | 3.53 | 407.02 | 13.38 |
| Administration, not otherwise allocated ..... | 4,071.07 | 2.95 | 339.26 | 11.15 |
| Taxes ..... | 3,632.83 | 2.63 | 302.74 | 9.95 |
| Repairs and replacements .. | 3,244.68 | 2.35 | 270.39 | 8.89 |
| Workmen's insurance ..... | 3,039.49 | 2.20 | 253.29 | 8.33 |
| Total expenses ..... | 117,939.81 | 85.31 | 9,828.32 | 323.12 |
| Net profit, carried to surplus | 20,315.87 | 14.69 | 1,692.99 | 55.66 |

The company state income taxes for 1935 amounted to $ 910.45, while the Federal tax was $1,839.90.

## Parker Claim

This claim is about 1-1/2 miles north of the Golden Belt mine; the vein is probably the north extension of the Golden Belt vein. Some 30 years ago ore containing 5 ounces of gold to the ton was shipped from this property to the old Humboldt smelter. On March 2, 1936, Henry Warmoth shipped 30 tons of ore from his leasing operation on the claim. He kindly furnished the following information:

Two adits, one 75 feet long and the other 45 feet long, have been driven on the strike of the vein by hand. The waste was stripped from above the ore, which was then taken up by picking. The average width of the ore was 2 to 3 inches. The recent shipment contained ore broken from nearby surface exposures of the vein in addition to that mined underground. It took one man and a boy 4 months to mine the 30 tons of ore, which is expected to assay about 1 ounce of gold and 4 to 6 ounces of silver to the ton. It was shipped to Superior, Ariz., and the freight rate will be about $3.50 per ton. The trucking charge to Mayer (14.5 miles by road) was $ 3 per ton.

## Gold Money

The Gold Money Mining Co. owns five claims adjoining the Golden Turkey on the south. There are two mineralized veins on the property. Joe O'Neill, using hand steel, is driving an incline that follows the upper vein for about 100 feet on its dip of 27° to the east. He expects to reach the intersection with the lower vein in another 100 feet.



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## Thunderbolt

The deep-carved canyon of Poland Creek, is met about 3½ miles southeast of Cleator by the tortuous channel of Turkey Creek to form the Black Canyon, which extends in a southerly direction from the point of confluence of the two streams. The Thunderbolt mine, now being operated under lease by the Black Canyon Mining Co., is located at this intersection on the east side of the canyon at an elevation of 2,900 feet above sea level. Most of the following information was obtained through the friendly cooperation of Gordon Tisdale, general manager.

The property includes 12 claims, the original location having been made in 1905. Although intermittent shipments of ore rich in ruby silver were made during the early days of the mine, there has never been a steady production.

The lode on the property is a quartz vein that occupies a fissure in the Yavapai schist. It strikes east and cuts squarely across the cleavage planes of the schist, which strike north; the dip is 44° to the north. Silver, occurring in a mixture of galena and sphalerite, is by far the most valuable metal in the ore, the average assay of the vein throughout the entire mine showing 8 ounces of silver to the ton, 1 percent lead, and 1-1/2 percent zinc.

### Mine

A main adit has followed the vein for about 1,000 feet and has been driven 600 feet farther for the purpose of prospecting. A raise 5 feet high and about 20 feet wide, virtually a stope, has been driven up 70 feet from the main drift on the vein, producing 480 tons of mill ore. The vein ranged in thickness from 4 to 12 inches; the value over the 5 feet broken was $14 per ton in silver. The drilling was done with detachable bits costing 30 cents each. Bits are sharpened by the manufacturer for 10 cents each, and shanks are threaded for 75 cents each.

Water for all purposes is pumped up 400 feet from Black Canyon Creek during its period of flow, usually from March to June. At other times small amounts of water are obtained from the mine and from two nearby shafts equipped with pumps.

A survey for a power line to the property has been completed recently, but the company now operates its own power plant. This consists of a 45-kv-a, 60-cycle, 3-phase, 220-volt generator driven by a caterpillar tractor engine. The engine operates on stove oil costing 5 cents per gallon and consumes 75 gallons per 24 hours when running steadily.

### Mill

The 25-ton flotation mill began operations May 1, 1935, and has operated intermittently for about 20 percent of the time since that date. The ore is crushed to 3/4 inch by a 7- by 10-inch Blake-type jaw crusher at the mine. It is then conveyed by a 20-foot shaker chute to a 90-foot slide, which delivers it to a 50-ton ore bin at the head of the mill. A conveyor feeds it to a 3- by 3-foot cylindrical ball mill driven by a 20-horsepower motor. A 14-inch by 12-foot drag classifier operates in closed circuit with the ball mill. Flotation reagents costing about 18 cents per ton of ore are introduced at two points in



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the flow sheet. Equal parts of xanthate 301 and xanthate 208, amounting to 0.15 pound each per ton of ore, are added to the ball-mill feed, and 0.1 pound of Aerofloat 31 and 0.05 pound of cresylic acid per ton are added near the classifier overflow.

The overflow from the classifier passes to two 28-inch flotation cells. The froth from the cells drops into a launder, where the coarser particles are allowed to settle; it is not broken down by wash water. The slimes run into a settling cone, and the coarser particles are shoveled out of the launder periodically and thrown onto a drying platform to be sacked when dry. The slimes that settle in the cone are drawn off at intervals and dried on a hot plate. The tails from the flotation cells flow through a launder to a concentrating table; the concentrates from the table are put back into the ball-mill feed and the tails are run to waste. The ratio of concentration averages about 15 to 1, but ratios as low as 8 to 1 and as high as 75 to 1 have been experienced.

The concentrates, which average about 300 ounces of silver per ton, 12 to 20 percent lead, and 40 percent zinc, are trucked to El Paso for $11 per ton. Inasmuch as the maximum penalty for zinc imposed by the smelter is $6 per ton of concentrates, and since the sphalerite carries more than $6 in silver, no effort is made to drop it in the mill. A flow sheet of the mill is shown in figure 6.

Monthly operating data at the mill for the 10 months from May 1, 1935, to March 1, 1936, are given below:

| | Tons milled | Tons of concentrates | Concentration ratio | Actual mill hours | Milling time, percent |
|---|---|---|---|---|---|
| Monthly range | 31 to 119 | 1.12 to 6.12 | 13 to 75 | 45 to 235 | 7.2 to 39 |
| Total ..... | 696.9 | 33.22 | ..... | 1,309.0 | Average 20 |

Corresponding figures for January 1936 were:

| | |
|---|---|
| Tons milled ..... | 49 |
| Tons of concentrates ..... | 3.08 |
| Concentration ratio ..... | 16 |
| Actual mill hours ..... | 86.5 |
| Milling time, percent ..... | 14 |

The concentrates made in January had a value of $150 per ton. Data on 12 shipments made in the 10-month period are as follows:

| | Net weight, pounds | Moisture, percent | Dry weight, pounds | Silver assay, ounces per ton | Value |
|---|---|---|---|---|---|
| | 2,503 to 11,777 | 1 to 9.8 | 2,355 to 11,459 | 159 to 602 | $273.93 to $2,258.06 |
| Total | 65,900 | Ave. 4.8 | 63,169 | ..... | $8,174.43, gross value at smelter. |
| | | | | | $6,732.30 net returns. |



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## Costs

The operating costs for January 1936 are shown in the following tabulation: The lessees pay a 10-percent royalty.

| | | | |
|---|---|---|---|
| **Mine:** | | | |
| Labor: | | | |
| Miners | $85.50 | | |
| Trammers | 66.50 | $152.00 | |
| Explosives | | 24.62 | |
| Supplies | | 21.85 | $198.47 |
| **Mill:** | | | |
| Labor: | | | |
| Operation | 52.88 | | |
| Repairs | 1.12 | 54.00 | |
| Reagents | | 20.44 | 74.44 |
| **Power plant:** | | | |
| Labor: | | | |
| Operation | 81.00 | | |
| Repairs | 4.43 | 85.43 | |
| Fuel and lubricating oil | | 74.58 | 160.01 |
| **Pump station:** | | | |
| Labor and repairs | | 4.00 | |
| Fuel and oil | | 2.50 | 6.50 |
| **Transportation:** | | | |
| Gas and oil | | | 24.77 |
| **Office:** | | | |
| Clerical | | 40.00 | |
| Supplies | | 4.78 | |
| Miscellaneous | | 2.83 | 47.61 |
| **General:** | | | |
| Supervision | | 200.00 | |
| Travel | | 2.00 | |
| Assays | | 4.50 | |
| Camp expense | | 28.38 | 234.88 |
| Total operating cost for January, 1936 | | | $746.68 |

## French Lily

The French Lily mine is about 1½ miles southwest of Cleator. Some high-grade ore was produced from the property prior to 1907, then the mine lay idle until 1922, when about 3 cars were shipped. No shipments have been made since that date. At present the property is being operated by the Southwest Metals & Mines, Inc.; work is limited to deepening the main shaft and building a change house. The enterprise is being financed by an $85,000 Reconstruction



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Finance Corporation loan, according to H. P. Moran, the general manager, through whose courtesy the accompanying data were obtained.

A quartz vein containing the ore on this property dips north at about 45°, following the contact between Yavapai schist on the hanging wall and diorite on the footwall. Two and one-half feet of the vein averages $10.19 in gold and $0.77 in silver to the ton in the upper workings and 0.49 ounce gold with a trace of silver in the lower 85 feet of the shaft.

It is proposed to mine the ore in open stopes. The management contemplates the erection in the near future of a 50-ton flotation mill on a side hill a few hundred feet southeast of the present shaft. The ore will be raised through a shaft that will connect the mill directly with extensions of the present mine workings.

The present main shaft is a 45° incline that follows the ore on its dip. The first level is 80 feet down the incline; drifts follow the vein 120 feet to the east and 140 feet to the west of the shaft. In the faces of the drifts the vein is not very well defined. The second level is 80 feet beyond the first, or 160 feet below the collar, measured on the incline. The east drift on the second level is only about 100 feet long, but the west drift follows the vein for 665 feet. The vein is not very distinct, however, in the last 100 feet of this drift.

From the second level two raises were driven on the ore. The first was started from a point about 400 feet west of the shaft; at a distance of 134 feet it broke into a short adit near the surface. The second raise is 100 feet farther west and follows the ore about 100 feet.

The levels are equipped with 18-inch-gage tracks of 8-pound rails, on which a 1,200-pound car was operated. The car has a scoop-shape front; it is dumped directly into a skip at the main incline.

The shaft is well-timbered with 8- by 8-inch 3/4 sets on 5-foot centers and close-lagged with 2 by 12's. The section of the incline measures 4-1/2 by 7 feet inside the timbers and is divided into a narrow manway and a skipway. The skip compartment is provided with 25-pound rails on a 24-inch gage.

The broken rock is hoisted in a 13-cubic foot self-dumping skip of 1,200 pounds capacity. It dumps into a hopper built into the headframe, from which the contents can be dumped directly as waste or loaded into 14-cubic foot cars to be trammed to other parts of the dump for storage. The hoist is of the single-drum, geared type, driven by a 20-horsepower variable-speed motor. It carries 500 feet of 1/2-inch wire rope and has a maximum hoisting speed of 275 feet per minute.

The bottom of the main incline is now (March 1, 1936) 85 feet below the 160-foot level; the rock section is 5 by 9 feet. A round consisting of 12 to 16 holes is drilled in one shift in the shaft bottom with two heavy plugger drills and breaks 4 to 4-1/2 feet. The same drills had previously been mounted for drifting. A center-cut round, modified to break to a slip along the hanging wall, is used; the drills take hollow, 1-inch round, lug steel, starting with a



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2-inch bit and finishing, through three changes, with a 1-5/8-inch bit. To keep the collar of the drillhole from sloughing a 1-foot length of 2-inch pipe is driven about 6 inches into the hole after starting. The pipes are shot up with the round. About half a box of 40-percent dynamite is used per round. Shots are fired electrically from the lighting circuit.

Three shifts per day are being worked in the shaft. The present daily pay roll is shown below:

| Number | Occupation | Rate | Per day |
|---|---|---|---|
| 1 | mine foreman | $ 7.00 | $ 7.00 |
| 3 | shaftmen | 5.00 | 15.00 |
| 3 | do | 4.50 | 13.50 |
| 6 | do | 4.00 | 24.00 |
| 3 | hoistmen | 3.50 | 10.50 |
| 1 | blacksmith | 4.00 | 4.00 |
| 1 | electrician and repairman | 4.00 | 4.00 |
| 1 | carpenter | 4.00 | 4.00 |
| 3 | topmen (constructing new change house) | 3.50 | 10.50 |
| 22 | Total pay roll per day | | $92.50 |

Air is furnished by a 6-cylinder, 2-stage compressor driven by a 60-horsepower motor with multiple V belt. It delivers air at 82 to 90 pounds per square inch to a 2-1/2-by 6-foot receiver. A 2-inch pipe line carries the air down the main incline to the second level, beyond which a 1-1/2-inch pipe line is used.

Considerable water is being encountered in the bottom of the incline. Two air-driven centrifugal pumps called "sponges" raise the water to a sump on the second level. From there it is pumped to a 6- by 6-foot tank on the surface by a 2-stage centrifugal pump driven by a 15-horsepower motor automatically controlled by a float on the sump.

Drill steel is heated in an oil forge burning "34-plus" oil. This grade of oil costs 7-1/2 cents per gallon at the mine; the forge consumes about 2 barrels of it per month. For about 2 hours each morning the blacksmith occupies himself in sharpening the 20 to 30 pieces of drill steel required per day.

The electric power bill for February 1936 was about $480 for 17,000 kw.-hr., or about 3-3/4 cents per kilowatt-hour.

Costs of supplies are in line with those at other properties in the district. Timber has recently been purchased at $40 per 1,000 board feet at the mine. Steel costs 15-1/2 cents per pound f.o.b. Prescott.

Near the hoist house the company is building a modern change house equipped with wash basins, showers, and toilets. Twenty individual clothes lockers have been provided. The building is heated by a centrally located stove of generous proportions.



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## Richinbar

The Richinbar mine is on the west bank of the Agua Fria River at an altitude of 3,400 feet. It is reached by the road leading east from Cordes, which forks 4½ miles from that town, the right branch continuing 6 miles southerly to the mine.

According to Wilson[5/], from about 1905 to 1908 the Richinbar Mines carried on extensive development work at this property, built a 20-stamp mill, and mined some 8,000 tons of ore that contained about $6 per ton in gold together with a little silver. Prior to 1922 the mine was operated by three different companies and in 1917 was unwatered and retimbered. Early in 1933 the Sterling Gold Mining Corporation obtained control of the property and prior to May 1934 made some surface improvements and carried on a little underground work. Through the courtesy of the mine superintendent, Robert Cooley, the following information was obtained:

The ore occurs as irregular shoots in a quartz vein that strikes north and dips at about 80° to the west. Iron is abundant throughout the vein, mainly as pyrite, but often oxidized to red hematite. Other sulphides are insignificant. The only metal of value is gold, which occurs free and gives the ore an average value of about $3 per ton.

Prior to July 1935 power was generated on the property by an alternator rated at 100 kv-a, 460 volts, 3-phase, 60 cycles, 900 r.p.m., driven by a 3-cylinder Diesel-type engine running at 300 r.p.m.

At present (March 1936) power is obtained from the local power company; it is stepped down to 440 volts for the mine and mill machinery. It costs about 1.8 cents per kw.-hr. or 35 to 40 cents per ton of ore for an output of 100 tons per day.

All the water used in the mill, as well as that required for camp purposes, is pumped from the Agua Fria.

In 1935 the company was operating three shifts a day extracting mill ore from all levels in the mine totaling about 110 tons per 24 hours. The mill was not operated during January or February 1936, and work in the mine has been intermittent. Expectations were that the mill would be started about March 9, 1936, and to increase the present mine force of 10 men so as to have a total payroll of 20 men for the mine and mill.

### Mine

The main shaft on the property is vertical and extends to the 500-foot level, which is 476 feet below the collar. The shaft was sunk in the hanging wall and cuts the vein between the 400- and 500-foot levels. The lowest development working is a sublevel 50 feet below the 500-foot level. Levels have been driven to the north and south at vertical intervals of about 100 feet, but all the ore so far mined has been obtained from workings north of the main shaft.

In early March 1936 work consisted of driving drifts on the 300-foot level and stoping ore from above the 200-foot level. Work was conducted only on day

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5/ Wilson, E. D., Arizona Lode Gold Mines: Arizona Bureau of Mines, Mineral Technol. Ser. 37, Bull. 137, 1934, pp. 54-55.



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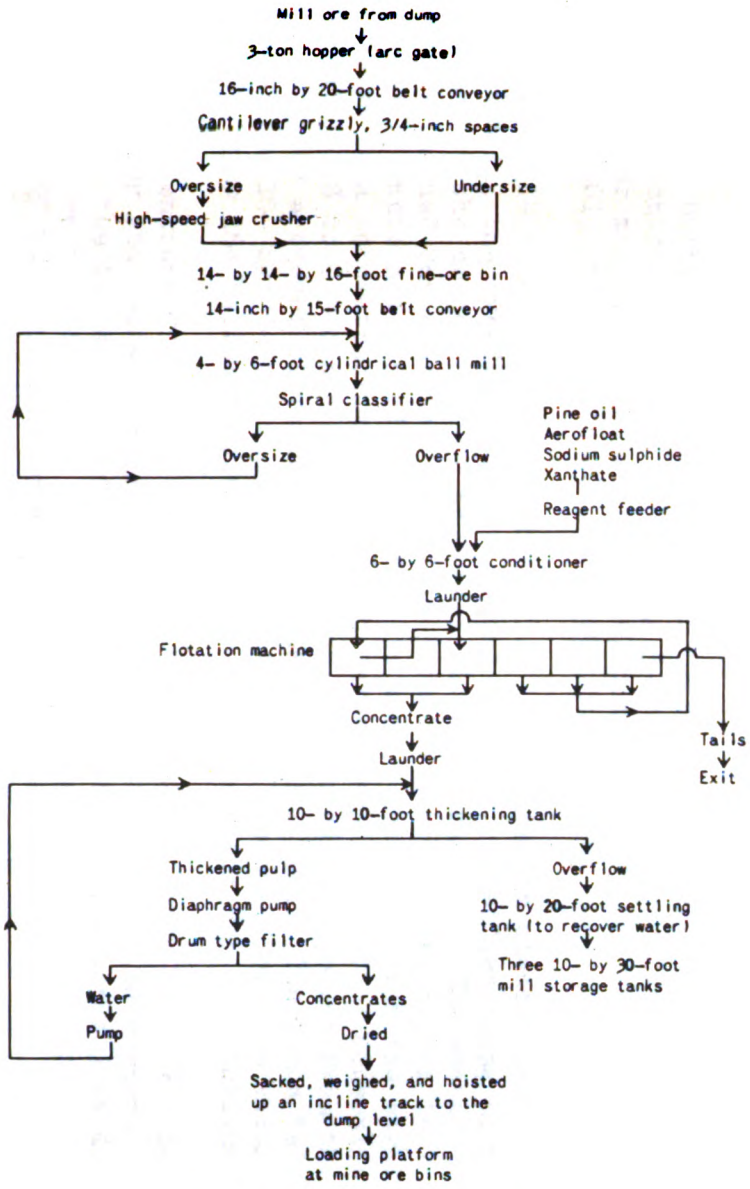


Figure 7.- Flow sheet of Swastika mill.

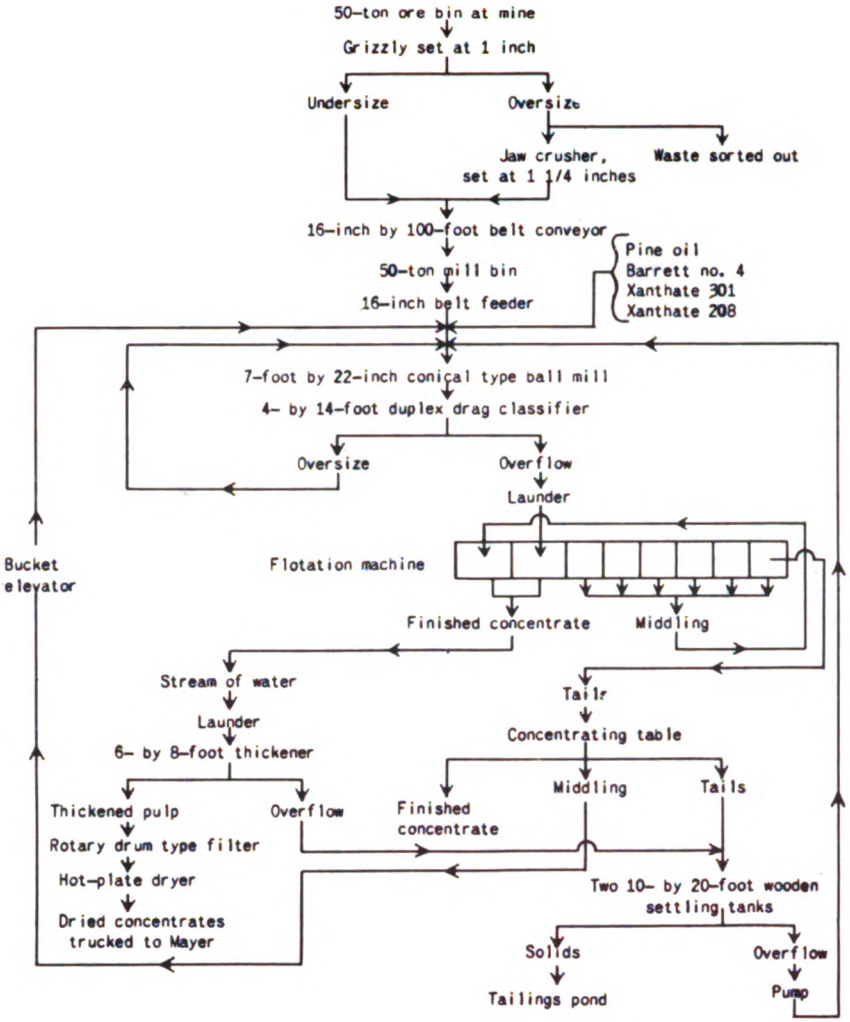


Figure 8.- Flow sheet of Richinbar mill.

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shift. Drifts are 5 by 7 feet and require about 45 sticks of 40-percent gelatin dynamite to break 3-1/2 feet. A round of 15 holes is drilled in a shift, using a drifting machine on a horizontal bar. Miners and trammers are paid alike $4 a day; millmen receive $4.50 a day. Compressed air for drilling is furnished by a 10- by 10-inch compressor driven by a 50-horsepower motor. The air passes through a 3- by 10-foot receiver and enters the mine through a 2-1/2-inch pipe line. Enough air is provided for three drills. Detachable bits are used for drilling and are sharpened at the mine by a grinder driven by the compressor motor. Cross bits and Carr bits both are used with 7/8-inch hollow hexagonal steel. Starting bits are 2-inch, and following sizes decrease by 1/8 inch.

Small mine cars holding about 1,000 pounds are hoisted on a single-deck cage. A single-drum, geared hoist is driven by a 40-horsepower motor and is equipped with 3/4-inch rope. All material is raised to the top of a 50-ton ore bin, which is built into the headframe and held together by diagonal tie rods through the corners. The small amount of waste that must be hoisted is trammed across the top of the ore bin and dumped from a trestle. The ore is dumped into the bin through a 4-inch grizzly made of 25-pound rails.

## Mill

The ore is fed by hand through the gate of the bin to a grizzly with bars set 1 inch apart. The oversize passes to a jaw crusher set at 1-1/4 inches, which is driven by a 30-horsepower motor with a 6-inch belt. Large pieces of waste are sorted out of the crusher feed by the man who regulates the gate at the bottom of the ore bin. The discharge from the crusher joins the undersize from the grizzly and both pass onto a 16-inch belt conveyor, 100 feet long, which delivers the ore to a 50-ton bin at the head of the mill. The conveyor is driven by a 3-horsepower motor with a multiple V belt drive.

From the bottom of the bin a 16-inch belt feeder conveys the ore to a 7-foot by 22-inch, conical-type, ball mill using 3-inch cast-iron balls and driven by a 100-horsepower motor. Flotation reagents, consisting of pine oil, Barrett no. 4, xanthate 301, and xanthate 208, are introduced at the head of the ball mill.

A 4- by 14-foot duplex drag classifier is operated in closed circuit with the ball mill, the overflow (minus 40-mesh) from the classifier being conveyed in a launder to the second cell of an 8-cell flotation machine. The second cell makes a finished concentrate. The froth from the last six cells goes to the first cell, where a finished concentrate is made. The tails from the eighth cell pass to a concentrating table, which makes a small amount of concentrate containing 0.8 to 0.9 ounce of gold per ton. The middling product from the table is carried by a bucket elevator back to the ball-mill feed. The table tails run into two 10- by 20-foot wooden settling tanks, the overflow from which is pumped back to the ball-mill circuit. The solids are run out to a tailings pond.

The concentrate froth from the first two flotation cells is broken down by a spray of water and passes through a launder to a 6- by 8-foot thickener. The overflow from the thickener runs into the two large settling tanks just described; the thickened pulp is delivered to a rotary drum-type filter. The product, containing from 20 to 25 percent water, is spread on a hot-plate drier using an oil burner. The flow sheet of the mill is shown in figure 8.



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Mill samples of flotation concentrates made during December 1935 follow:

| | Ounces of gold per ton (3 shifts) | | |
|---|---|---|---|
| December 5 ..... | 6.12 | 9.52 | 5.22 |
| 6 ..... | 8.08 | 6.44 | 8.66 |
| 7 ..... | 5.06 | 8.46 | 16.94 |
| 8 ..... | 6.16 | 13.50 | 9.36 |
| 9 ..... | 6.42 | 10.02 | 9.38 |
| 10 ..... | 9.14 | 5.88 | 7.30 |

A lot of 22 tons of concentrates, shipped December 8, 1935, contained 8.34 ounces of gold and 1.92 ounces of silver per ton. The smelter settlement for a lot shipped January 9, 1936, showed a wet weight of 39,600 pounds, moisture, 2.7 percent, and a dry weight of 38,531 pounds.

Gold payment:

| | |
|---|---|
| 5 ounces at $32.81825 ..... | $ 164.09 |
| 1.4 ounces at $33.1743125 ..... | 46.44 |
| | 210.53 |

Assay:

| | | |
|---|---|---|
| Gold ..... | 6.40 ounces, valued as shown above ..... | $210.53 |
| Silver ..... | 1.3 ounces - 0.5 = 0.8, at $0.755 (silver quotation = $0.77) ..... | .60 |
| Lead ..... | 0.7 | |
| Copper ..... | .2 | |
| | No pay | |
| | | 211.13 |

Treatment charge ..... $ 5.00

Analysis:

| | Percent | Penalty | |
|---|---|---|---|
| Insoluble ..... | 59.4 | | |
| Fe ..... | 15.8 | | |
| Zn ..... | .1 | | |
| S ..... | 6.1 | | |
| $Al_2O_2$ ..... | 2.9 | | |
| As+Sb ..... | 5.72 - 5 = 0.72 at 1.00 = | 0.72 | 5.72 |
| | | | 205.41 |

| | | |
|---|---|---|
| 19.2655 tons at $205.41 ..... | | $ 3,957.33 |
| Freight to Hayden ..... | $241.50 | |
| Sacks returned at 40 cents per ton of concentrates (30-ton minimum) | 12.00 | |
| Withheld pending receipt of silver affidavit ..... | 4.05 | 257.55 |
| Net returns ..... | | 3,699.78 |



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Metallurgical data for 10 months in 1935

| Month | Days | Tons milled | Average ounces of gold per ton | | | Average recovery, percent | Ratio of concentration |
|---|---|---|---|---|---|---|---|
| | | | Heads | Tails | Concentrates | | |
| March | 1 - 15 | 474 | 0.25 | 0.038 | ..... | 87.3 | ..... |
| | 16 - 31 | 679 | .24 | .03 | ..... | | |
| April | 1 - 15 | 684 | .26 | .04 | 12.23 | 84 | 56 |
| | 16 - 30 | 763 | .21 | .03 | 9.94 | | 61 |
| May | 1 - 15 | 889 | .24 | .03 | 12.70 | 85 | 62 |
| | 16 - 31 | 823 | .17 | .02 | 8.96 | 87 | 66 |
| June | 1 - 15 | 918 | .21 | .03 | ..... | 87 | 62 |
| | 16 - 30 | 910 | .18 | .03 | 9.6 | 85 | 67 |
| July | 1 - 15 | 859 | .17 | .02 | 10.2 | 86 | 76 |
| | 16 - 31 | 379 | .11 | .01 | 5.2 | 89 | ..... |
| August | 1 - 15 | 1,570 | .11 | .02 | 9.0 | 82 | 93 |
| | 16 - 31 | 1,730 | .11 | .02 | 9.65 | 84 | 106 |
| September | 1 - 15 | 1,674 | .09 | .02 | 13.2 | 81 | 140 |
| | 16 - 30 | 1,637 | .09 | .014 | 8.46 | 83 | 129 |
| October | 1 - 15 | 919 | .10 | .012 | ..... | ..... | ..... |
| | 16 - 31 | 1,420 | .07 | .01 | 7.72 | 85 | 144 |
| November | 1 - 15 | 1,430 | .07 | .01 | 6.1 | 82 | 111 |
| | 16 - 30 | 1,402 | .09 | .01 | ..... | 86 | 132 |
| December | 1 - 15 | 1,575 | .07 | .01 | 8.56 | 86.5 | ..... |
| | 16 - 31 | 1,102 | .07 | .01 | 6.8 | 86 | 111 |

## Silver Cord

The Silver Cord mine is reached by a short branch road that turns south from the Crown King road 1¼ miles west of the Black Canyon highway. It is 1 mile southeast of Cleator. The property is said to have produced 20 or 30 carloads of ore up to about 1912. In that year, according to Wilson[6], 224 tons were shipped, containing gold, silver, copper, and lead valued at $40.67 a ton. Mr. Cleator states that he shipped about 12 carloads from the property. The first-class ore was valued at about $75 per ton; the second-class at $18 or more. The Mineral Resources of the United States credits the Silver Cord mine with a small production of ore in each of the years 1925, 1928, 1929, and 1930.

This property was leased for the 5 years ended September 1935 to K. C. McCutchan, who kindly supplied the following information. He is improving the

6/ Op. cit., p. 53.



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road to the mine and awaiting action on an application for a Government development loan of $20,000.00. Application has also been made for a mill loan.

A vein of quartz ranging in width up to 2 feet carries a mixture of galena and pyrite, with which are associated gold and silver minerals. The vein cuts the Yavapai schist and diorite dikes.

A main incline has been driven due south on a dip of about 11° SE. and follows the ore for about 300 feet. A little drifting has been done both to the east and west. A small compressor furnished the air for the single drill that was used.

No stoping was done, the ore shipments being obtained from the development work. The waste rock was stripped from above the ore by drilling and blasting, and the ore was removed subsequently by picking. A total height of about 6 feet was broken.

During the period of the lease 500 tons of ore were shipped from the property; most of the tonnage went to El Paso, but some lots were sent to Hayden and some to the Magma Copper Co. The following figures summarize these shipments:

| | |
|---|---|
| Total gold in the ore .....ounces | 313.6 |
| Total silver in the ore ..... do. | 14,644 |
| Total lead in the ore .....pounds | 62,560 |
| Average moisture .....percent | 2.8 |
| Total metals paid for ..... | $15,860.00 |
| Net returns ..... | 9,954.00 |
| Total royalty paid ..... | 1,310.00 |

The royalty was 10 percent for 3 years and 15 percent for 2 years; during the latter period the lessee had the use of the compressor and a hoist.

The last car was shipped to El Paso on October 4, 1935. It contained 30 tons of ore assaying as follows:

| | | Value |
|---|---|---|
| Gold .....ounce per ton ... | 0.685 | $ 22.48 |
| Silver .....ounces per ton .. | 21.96 | 15.74 |
| Lead .....percent ..... | 9.5 | 4.67 |
| Copper ..... do ..... | .43 | No pay |
| Total value ..... per ton ..... | | $ 42.89 |

The smelter charges and penalties against this shipment were as follows:



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Charges:

| | |
|---|---|
| Base charge for ore not exceeding $25 per ton ..... | $ 3.70 |
| 10 percent of $17.89, excess over $25 per ton ..... | 1.79 |

Penalties:

| Item | Percent | Deduction, percent | Net, percent | Rate, per unit | | |
|---|---|---|---|---|---|---|
| Insoluble ... | 51.0 | 40.0 | 11.0 | 5 cents | .55 | |
| $SiO_2$ ..... | 45.6 | ..... | ..... | ..... | ..... | |
| $Al_2O_3$ ..... | 5.0 | ..... | ..... | ..... | ..... | |
| Zn ..... | 6.2 | 8.0 | ..... | ..... | 1.68 | |
| S ..... | 9.4 | 1.0 | 8.4 | 20 cents | 3.13 | |
| AstSb ..... | 8.25 | 2.0 | 6.25 | 50 cents | ..... | |
| Fe ..... | 9.7 | ..... | ..... | ..... | ..... | |
| CaO ..... | .2 | ..... | ..... | ..... | ..... | $10.85 |
| Net value per ton ..... | | | | | | $32.04 |

The freight rate to El Paso on this shipment was $4.75 per ton. In making settlement it has been the policy of the smelter to withold an amount equal to the difference between the foreign and domestic value of the silver, pending the receipt from the shipper of an affidavit stating that the silver was mined subsequent to December 21, 1933, from natural deposits at the mine.

## Idle Mines in the Black Canyon District

### Hidden Treasure

The old Hidden Treasure mine near the Silver Cord property has not been operated for many years. The steep-dipping workings were unwatered during 1935 but no ore was extracted.

### Rainbow Lode[7]

The Rainbow deposit is 1½ miles northeast of Cleator. It is a lenticular mass of sulphides and gangue some 200 feet wide, lying in biotite schist. The ore is low-grade. A shaft has been sunk 100 feet on a stringer east of the main deposit.

### Howard Copper Co.[8]

The property of the Howard Copper Co. is in Black Canyon 16 miles south-southeast of Cleator. A tunnel has been driven 560 feet in chloritic schist. Crosscuts from the tunnel have cut a lens of ore said to contain 9.5 percent copper, $2.80 in gold, and one ounce of silver per ton. The mineralized material is about 20 feet wide and is said to assay 1 to 2 percent copper.

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7/ Lindgren, op. cit., p. 154.

8/ Lindgren, work cited, pp. 154-155.



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## Howard Silver Co.[9]

The Howard Silver Co. property is about 1 mile from the mine of the Howard Copper Co. A flat quartz vein 2 feet wide and carrying galena and sphalerite has been followed by an incline for 200 feet. It is said that about 1 carload of silver ore has been shipped. A flotation mill was built in 1924.

## PECK DISTRICT[10]

The Peck mining district, north of Crown King, occupies a few square miles in the drainage areas of Peck Canyon and Bear Creek. The altitude ranges from 5,000 to 6,000 feet. Toward the east the country drops off to the deep depression of Crazy Basin.

The principal formation in the district is the Yavapai schist. The ore deposits are largely silver-bearing veins, but the district includes one important disseminated-copper deposit.

Table 3 shows the amount and value of the metal production of the Peck district from 1904 to 1933. Table 4 shows the production of the district by mines.

### Swastika

The old Swastika mine, now being operated by the Gold Crown Silver Mining Co., is in the Peck mining district near the western rim of Crazy Basin at an altitude of 5,200 feet. The mine is reached by a narrow road that climbs precipitously for about 1½ miles after leaving the Crown King road some 5½ miles northwest of Cleator. According to Lindgren[11], the Silver Prince claim of this group is mentioned in Raymond's report of 1877. The mint report for 1883 mentions both the Silver Prince and Black Warrior veins, stating that the Black Warrior vein was 2 to 3 feet wide, that $40,000 in silver had been extracted so far, and that 8 tons a day were milled in a 4-stamp mill with a yield of 113 ounces of silver to the ton. About 1885 the mine was considered exhausted, and it remained idle until 1910. From 1910 to 1915 the mine produced 600,000 ounces of silver, since which time it has been in intermittent operation. The earliest production from the Curtin claim, the scene of present operations, was in 1923. The information that follows was obtained through the friendly cooperation of O. I. Tawney, manager of the property.

The country rock is Yavapai schist. Two parallel and nearly vertical lenticular bodies of quartzite, locally known as quartzite dikes, cut across the property in a general northeasterly direction. They are 10 to 50 feet wide in most places and are generally about 15 to 50 feet apart. In the area between them lie the ore bodies. These consist mainly of shoots in narrow veins that carry a mixture of sulphide and oxidized minerals sparsely distributed through the altered and silicified vein matter. The ore bodies range in width up to 4 feet. The only metal of value is silver, which occurs conspicuously as the chloride, cerargyrite. The general dip of the ore bodies is 80° to the northwest.

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9/ Lindgren, work cited, p. 159.
10/ Lindgren, work cited, p. 160.
11/ Work cited, p. 162.



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TABLE 3. - Production of Peck district, Yavapai County 1904-33[1/]

| Year | Producers | | Tons | Gold value | Silver, ounces | Copper, pounds | Lead, pounds | Zinc, pounds | Total value |
|---|---|---|---|---|---|---|---|---|---|
| | Lode | Placer | | | | | | | |
| 1904 | .... | ..... | 15 | $ 83 | ..... | ..... | ..... | ..... | $ 83 |
| 1905 | .... | ..... | 3,594 | 29,829 | 37,166 | ..... | ..... | ..... | 52,277 |
| 1906 | .... | ..... | 27,411 | 52,907 | 27,660 | 1,219,040 | 3,900 | ..... | 307,213 |
| 1907 | .... | ..... | 23,571 | 53,972 | 34,933 | 682,388 | ..... | ..... | 213,506 |
| 1908 | 4 | ..... | 413 | 3,064 | 6,454 | ..... | ..... | ..... | 6,485 |
| 1909 | 1 | ..... | 5 | ..... | 216 | ..... | ..... | ..... | 112 |
| 1910 | 1 | ..... | 1 | 19 | 6 | 119 | ..... | ..... | 37 |
| 1911 | 4 | ..... | 546 | 4,352 | 30,157 | 5,512 | 34,140 | ..... | 22,560 |
| 1912 | 2 | ..... | 489 | 290 | 78,870 | 1,242 | 59,535 | ..... | 51,679 |
| 1913 | 2 | ..... | 431 | 465 | 102,706 | 1,719 | 80,898 | ..... | 66,325 |
| 1914 | 2 | ..... | 112 | 127 | 17,573 | 644 | 23,505 | ..... | 10,847 |
| 1915 | 3 | ..... | 8,540 | 6,589 | 34,772 | 560,208 | 19,803 | ..... | 123,185 |
| 1916 | 2 | ..... | 34,676 | 24,347 | 59,627 | 1,618,189 | 14,434 | ..... | 462,652 |
| 1917 | 2 | ..... | 44,722 | 53,022 | 78,683 | 2,701,386 | 11,882 | ..... | 856,357 |
| 1918 | 3 | ..... | 45,699 | 46,903 | 127,511 | 2,213,941 | 10,133 | ..... | 721,977 |
| 1919 | 4 | ..... | 28,473 | 21,358 | 60,702 | 1,130,828 | 176 | ..... | 299,686 |
| 1920 | 3 | ..... | 20,316 | 12,852 | 41,305 | 723,548 | 686 | ..... | 191,062 |
| 1921 | 1 | ..... | 39 | ..... | 1,360 | 38 | 669 | ..... | 1,395 |
| 1922 | 3 | ..... | 151 | 342 | 4,407 | 782 | ..... | ..... | 4,855 |
| 1923 | 3 | ..... | 561 | 1,185 | 46,778 | 6,507 | ..... | ..... | 40,499 |
| 1924 | 1 | ..... | 548 | 52 | 36,367 | 1,647 | ..... | ..... | 24,634 |
| 1925 | 1 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 1926 | 2 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 1927 | .... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 1928 | 3 | ..... | 12,649 | 7,151 | 31,410 | 878,473 | 2,552 | ..... | 152,174 |
| 1929 | 2 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 251,858 |
| 1930 | 1 | ..... | 6,000 | ..... | ..... | ..... | ..... | ..... | 125,000 |
| 1931 | .... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 1932 | .... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 1933 | 1 | ..... | 14 | 152 | ..... | ..... | ..... | ..... | 152 |
| Total | .... | ..... | 258,976 | $ 319,061 | 858,663 | 11,747,211 | 262,314 | ..... | $ 3,986,610 |

1/ Elsing, M. J., and Heineman, R. S., Arizona Metal Production: Arizona Bureau of Mines Bull. 140, 1936, p. 84.



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TABLE 4 - Production of Peck district by mines[1/]

| | Copper, pounds | Lead, pounds | Gold, value | Silver, value | Total value |
|---|---|---|---|---|---|
| Peck, 1875-85 ..... | ..... | ..... | ..... | $ 1,000,000 | $ 1,000,000 |
| Swastika, 1875-1929 . | ..... | 200,000 | ..... | 900,000 | 910,000 |
| Breslin, 1925 ..... | ..... | 50,000 | ..... | 25,000 | 30,000 |
| DeSoto, 1890-1930 ... | 18,200,000 | ..... | $ 250,000 | 150,000 | 3,250,000 |
| Total | 18,200,000 | 250,000 | 250,000 | 2,075,000 | 5,190,000 |

1/ Elsing, M. J., and Heineman, R. S., Arizona Metal Production: Arizona Bureau of Mines Bull. 140, 1936, p. 102.

Mine

The mine is developed by adits on the 100-, 200-, and 300-foot levels that intersect the vein at distances of about 100, 200, and 300 feet from the respective portals. Drifts extend along the vein for three or four hundred feet in both directions. The southwest drifts on the 100- and 200-foot levels have broken into the old workings on the Silver Prince claim. From the 300-foot level a winze has been sunk about 200 feet, on the vein and drifts have been driven on the 400- and 500-foot levels. Some stoping has been done on the 400-foot level.

The ore was mined by a cut-and-fill system apparently well adapted to the steep dip of the vein and permitting the sorting out of most of the waste in the stope. No underground work was carried on in March 1936, the new mill being supplied with ore from the dump. Mine equipment is held in readiness to resume operations at any time. There is a 12- by 10-inch compressor, driven by a 50-horsepower motor, capable of delivering air at 85 pounds pressure to the three or four drills in the mine.

A modern drill sharpener handles the three types of hollow steel on hand - 1-1/4-inch round lugged steel for drifting, 1-inch quarter-octagon for the stopers, and 7/8-inch hexagon for the pluggers. The starting size of bit for drifting is 2-1/2 inches.

Miners are paid $4.50 per day and muckers $4.00. Good board is provided at $1.25 per day.

From August 1934 to the end of that year nine 50-ton cars of ore were shipped to El Paso. The silver content of these shipments ranged from 51 to 145 ounces per ton, the average being 117 ounces.

Twenty-nine cars were shipped from January to October 1935. The silver content ranged from 52 to 134 ounces per ton, almost the same as for 1934, but the average was only 72 ounces.

The ore was trucked to Mayer 23 miles away for $4 per ton. Freight costs from Mayer to El Paso were based on the value of the ore and therefore varied somewhat for the different shipments; but the average freight cost for the 1934



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shipments was about $5.15 per ton. The smelter treatment cost averaged $3.50 per ton.

## Mill

Tests indicated that the cyanide process was preferable from the metallurgical standpoint. The cost of such a plant, however, decided the management against it, and although the foundation had been laid, plans were abandoned in favor of a less costly flotation mill. Flotation experiments indicated a maximum recovery of 70 to 75 percent; the management is striving valiantly to achieve that result.

In January 1936 the new mill began operations on ore from a special dump containing, at the start, about 3,000 tons. A slusher is (March 1936) operated along the side of the dump, taking slices near the bottom and raising the broken ore to a small wooden hopper just above the dump level. The slusher is actuated by a wire rope wound on a small drum mounted on the rear of a caterpillar tractor. The tractor engine furnishes the power. The hopper discharges into a 1-ton mine car which is trammed about 200 feet to the head of the mill. The flow sheet of the mill, shown in figure 7 should be considered mainly experimental.

The mine car of ore is dumped into a 3-ton hopper equipped with an arc-type gate. This delivers the ore to a 16-inch belt conveyor 20 feet long, which discharges onto a cantilever grizzly with bars set 3/4-inch apart. The oversize passes through a high-speed jaw crusher and joins the undersize in a fine-ore bin 14 feet square and 16 feet high. A 14-inch belt conveyor 15 feet long delivers the fine ore to a 4- by 6-foot cylindrical ball mill using 4-inch steel balls. A spiral classifier driven by a 3-horsepower motor is in closed circuit with the ball mill.

The classifier overflow, consisting of 5 percent plus 60-mesh material, runs into a 6- by 6-foot conditioner, into which a reagent feeder drops the flotation reagents. The quantities of the reagents used, as well as the nature of the reagents, are entirely experimental. At present the following mixture is fed to the conditioner:

| | |
|---|---|
| Sodium sulphide ..... | 1-1/3 pounds per ton of ore. |
| Xanthate ..... | 1/2 pound per ton of ore. |
| Aerofloat ..... | 60 drops per minute. |
| Pine oil ..... | 30 drops per minute. |

The conditioned ore is conducted through a launder to the third cell of a 6-cell flotation machine. This cell makes a finished concentrate. The froth from the fourth, fifth, and sixth cells passes to the first cell, which also makes a finished concentrate. The middling product from the first cell is conditioned further in the second cell and joins the original feed in the third cell. The tails from the sixth cell are run to waste.

Water breaks down the concentrate froth and conveys it through a short launder to a 10- by 10-foot thickening tank, from which a diaphragm pump delivers the thickened pulp to a drum-type filter equipped with a vacuum pump and blower. The filter is operated only 3 hours a day.



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The concentrates are scraped off the filter as a paste and dried by being spread out in the sun. They are then sacked, weighed, and hoisted up an inclined track alongside the mill building to the dump level. They are trammed about 500 feet to a loading platform at the mine ore bins.

The water from the filtered concentrates is pumped back to the thickener, the overflow from which passes to a 10- by 20-foot settling tank and thence to three 10- by 30-foot mill storage tanks. The mill uses about three tons of water per ton of ore, about half of the water being returned. The management considers scarcity of water one of its major problems. Excavation has been started for a tailings dam on the steep hillside below the mill as part of the water recovery program.

The first concentrates were shipped to El Paso February 28, 1936. The shipment contained 25 tons and was estimated to assay 360 ounces of silver per ton. The following assay results were obtained from samples taken from February 24 to 27, 1936:

Ounces of silver per ton

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Heads ..... | 22.2 | 24.0 | 34.2 | 20.0 | 18.6 | 22.4 | 14.0 | ..... | ..... |
| Tails ..... | 8.0 | 8.2 | 7.8 | 7.4 | 11.6 | 6.0 | 5.6 | ..... | ..... |
| Concentrates . | 848.0 | 450.0 | ..... | ..... | 325.0 | ..... | .... | 512.0 (9,660 pounds) | 358.0 (4,270 pounds) |

The first, second, and fifth groups of assays in the series above show recoveries of 64.6, 69.5, and 64.1 percent, respectively.

The fundamental problem of floating silver chloride and the formation of considerable slimes, resulting in unsatisfactory filtering of the concentrates and difficulty in the recovery of water, constitute a real challenge to the management of this company and to the technique of mineral extraction.

## Idle Mines in the Peck District

### Peck[12/]

The Peck mine is one of the old-time silver bonanzas. The deposit, according to Raymond's reports, was discovered June 16, 1875, by E. G. Peck. Rich ore was found from the start. In the Mint report of 1883 the mine is mentioned as highly productive. At that time the levels aggregated 1,400 feet in length and a shaft 400 feet deep was sunk. There was a 10-stamp mill on the property. About $1,000,000 to $1,500,000 in silver is the reported production between 1875 and 1885. Since then there has been some intermittent work by lessees and in 1922 steps were taken to reopen the property.

The country rock is quartzite, a lens in the Yavapai schist. There are three veins that follow the strike and dip of the schist. The ore appears to have made in the quartzite. Tunnels follow the vein, and there are two shafts. The principal ore mineral was evidently bromyrite. A specimen of sulphide ore from

12/ Lindgren, work cited, p. 161.



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the 300-foot level is said to have contained 19.5 percent copper, 24 percent antimony, and 3,800 ounces of silver to the ton.

## De Soto[13/]

The outcrops of the De Soto copper mine lie 2 miles northeast of the Peck mine. The altitude is about 5,800 feet. The main tunnel is 600 feet below the outcrop. Work was discontinued in 1922, the ore bodies being considered exhausted.

The ore bodies, which carry pyrite-chalcopyrite ore, have yielded a total of 180,000 tons, averaging about 3.75 percent copper with 1 ounce of silver and 0.02 ounce of gold to the ton. The gangue is fine-grained quartz. Gangue and sulphides replace the schist, which is mainly chloritic. On the upper levels there were seven overlapping lenses, with an individual width of as much as 50 feet and a maximum length of 250 feet. The total length of the ore zone is 350 feet; the total width, 200 feet. The ore bodies are said to have been cut off in depth by a flat fault 250 feet below the surface. The small bodies found below this depth are believed to represent the continuation of the ore below the fault.

## PINE GROVE DISTRICT[14/]

The Pine Grove district lies in the heart of the Bradshaw Mountains at an altitude of 6,000 to 7,500 feet. Most of the mines are in granodiorite, which is cut by a series of dikes. Few of the veins are more than 5 feet wide, and they contain a filling predominantly of quartz with some ankerite and calcite. All of these veins are of a similar type, and it is believed that they have a genetic connection either with the granodiorite or with a system of rhyolite porphyry dikes.

Most of the ore extracted has been partly oxidized, and some of the ore is very rich, both in gold and silver, reaching assay values of $100 a ton. The primary ores are not rich as a rule. In few places do they seem to average better than $10 a ton. The water level is deep.

Table 5 shows the amount and value of the metal production of the Pine Grove and Tiger districts from 1901 to 1933. Table 6 shows the production of the Pine Grove district by mines.

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13/ Lindgren, work cited, pp. 162-164.
14/ Lindgren, work cited, pp. 164-165.



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TABLE 5. - Production of Pine Grove and Tiger Districts, Yavapai County,[1/] 1901 - 1933

| Year | Producers | | Tons | Gold value | Silver, ounces | Copper, pounds | Lead, pounds | Zinc, pounds | Total value |
|---|---|---|---|---|---|---|---|---|---|
| | Lode | Placer | | | | | | | |
| 1901 | .... | ..... | ..... | $ 1,344 | 1,087 | ..... | ..... | ..... | $ 1,996 |
| 1902 | .... | ..... | 112 | 661 | 822 | ..... | ..... | ..... | 1,091 |
| 1903 | .... | ..... | 4,000 | 36,941 | 8,124 | ..... | ..... | ..... | 41,291 |
| 1904 | .... | ..... | 5,430 | 81,635 | 10,606 | ..... | ..... | ..... | 85,305 |
| 1905 | .... | ..... | 31,796 | 279,173 | 48,638 | 121,157 | ..... | 140,000 | 339,166 |
| 1906 | .... | ..... | 16,858 | 179,551 | 19,984 | 40,119 | ..... | ..... | 200,690 |
| 1907 | .... | ..... | 8,097 | 96,652 | 11,577 | 21,562 | ..... | ..... | 108,605 |
| 1908 | 4 | ..... | 5,374 | 43,046 | 20,103 | ..... | 16,096 | ..... | 54,377 |
| 1909 | 1 | ..... | 1,336 | 31,361 | 2,726 | 4,802 | ..... | ..... | 33,403 |
| 1910 | 6 | ..... | 3,916 | 63,666 | 41,729 | 16,800 | 14,281 | ..... | 88,961 |
| 1911 | 5 | ..... | 21,568 | 75,902 | 169,045 | 55,332 | 25,530 | ..... | 173,562 |
| 1912 | 6 | ..... | 11,899 | 33,574 | 107,530 | 17,731 | 70,780 | ..... | 105,816 |
| 1913 | 2 | ..... | 3,296 | 4,162 | 2,228 | 16,462 | 2,982 | 57,160 | 11,392 |
| 1914 | 7 | ..... | 1,174 | 6,342 | 576 | 391 | 2,818 | ..... | 6,823 |
| 1915 | 3 | ..... | 3,101 | 4,857 | 2,173 | 12,176 | ..... | 48,580 | 14,114 |
| 1916 | 2 | ..... | 9,624 | 44,191 | 27,561 | 123,195 | 1,372 | 537,768 | 164,789 |
| 1917 | 4 | ..... | 6,848 | 35,423 | 21,805 | 92,149 | 20,723 | 528,360 | 134,223 |
| 1918 | 4 | ..... | 12,440 | 49,269 | 88,252 | 80,643 | 1,774 | ..... | 157,566 |
| 1919 | 8 | ..... | 1,455 | 5,251 | 16,153 | 32,903 | ..... | ..... | 29,463 |
| 1920 | 5 | ..... | 332 | 1,077 | 10,420 | 17,314 | ..... | ..... | 15,621 |
| 1921 | 2 | ..... | 145 | 1,831 | 8,052 | ..... | 5,226 | ..... | 10,118 |
| 1922 | 9 | ..... | 173 | 1,097 | 10,362 | 713 | ..... | ..... | 11,555 |
| 1923 | 8 | ..... | 82 | 1,772 | 2,227 | 971 | ..... | ..... | 3,741 |
| 1924 | 1 | ..... | 26 | 455 | 12 | ..... | ..... | ..... | 463 |
| 1925 | 1 | ..... | 30 | ..... | ..... | ..... | ..... | ..... | ..... |
| 1926 | 1 | ..... | 30 | ..... | ..... | ..... | ..... | ..... | ..... |
| 1927 | .... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 1928 | 2 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 1929 | 1 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 1930 | .... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 1931 | 2 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 1932 | .... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 1933 | 1 | 2 | 27 | 694 | 83 | 47 | ..... | ..... | 726 |
| Total | ..... | | 149,169 | 1,079,927 | 631,875 | 654,467 | 161,582 | 1,311,868 | 1,794,857 |

1/ Elsing, M.J., and Heineman, R. S., Arizona Metal Production: Arizona Bureau of Mines Bull. 140, p. 85.



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TABLE 6. -- Production of Pine Grove district by Mines[1/]

| | Copper, pounds | Lead, pounds | Gold, value | Silver, value | Total value |
|---|---|---|---|---|---|
| Wildflower, 1917-19 ..... | 400,000 | ..... | $ 15,000 | $ 30,000 | $ 104,000 |
| Crown King, 1893-1922 .... | ..... | ..... | 1,100,000 | 100,000 | 1,200,000 |
| Lincoln, 1902-8 ..... | ..... | ..... | 100,000 | 35,000 | 135,000 |
| Del Pasco ..... | ..... | ..... | 200,000 | ..... | 200,000 |
| Philadelphia ..... | ..... | ..... | 100,000 | ..... | 100,000 |
| Total ..... | 400,000 | ..... | 1,515,000 | 165,000 | 1,739,000 |

1/ Elsing, M. J., and Heineman, R. S., Arizona Metal Production: Arizona Bureau of Mines Bull. 140, 1936, p. 101.

## Crown King

The Crown King mine is well up in the eastern foothills of the Bradshaw Mountains west of the Black Canyon district. It has been the largest producer in the Pine Grove Mining district and is about 1½ miles from the town of Crown King, which lies at an altitude of 6,000 feet above sea level. The mine is now idle. Wilson[15/] states that during the early days rich gold ore was mined from near the surface. From 1890 to 1895 the property was operated by the Crown King Mining Co. Its 10-stamp mill recovered $10 to $12 per ton on the plates and made a lead concentrate that contained $150 to $350 in gold and silver per ton. The middlings were stock-piled. In 1895 the property was bonded to H. B. Chamberlin & Co., of Denver. The mine was operated until 1901, when it was closed by court order. During the 1890-1901 period the ore shoot was followed to a depth of 650 feet with an estimated production of $1,500,000, of which $200,000 was paid in dividends.

During 1906 and 1907 the Crown King Mines Co. worked the old middlings pile and shipped concentrates containing gold, silver, zinc, iron, and copper.

In 1909 the property was sold at receiver's sale to the Yavapai Consolidated Gold-Silver-Copper Co., controlled by the Murphy estate, for $75,000. In 1916 lessees organized the Bradshaw Reduction Co., which installed flotation equipment and made a few tons of concentrates from old middlings. Some ore is reported to have been blocked out above the 480-foot level but was not mined.

In 1923 the mine was taken over by the Crown King Consolidated Mines, Inc. During the winter of 1926-27 a flood wrecked the mill. The railway tracks from Middleton to Crown King were torn up during 1926 and 1927 and the grade has been utilized for a road. In 1933-34 a 300-ton flotation-concentration mill was built.

The production of the mine since 1890 is estimated at $1,840,000.

The Crown King vein averaging 2 feet in width, strikes north-northeast and dips 70° W. The ore consists of quartz with sphalerite pyrite and chalcopyrite. It is said to contain 0.5 ounce of gold and 4 ounces of silver per ton.

15/ Work cited, pp. 56-57.



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The mine workings include a 480-foot shaft, a 913-foot tunnel 150 feet below the collar, and a 500-foot winze with five levels, each of which extends about 1,200 feet north and from 200 to 500 feet south. Water stands 250 feet below the tunnel level.

According to the caretaker at the mine, the last ore treated in the mill was taken from the surface of the California claim. Assays available at the mine office showed the following values of this ore and the mill products:

| | Gold, per ton | Silver, per ton | Total value per ton of ore |
|---|---|---|---|
| July 4, 1935: | | | |
| Day shift: | | | |
| Heads | $ 5.25 | $ 1.33 | $ 6.58 |
| Tails | .52 | .18 | .70 |
| Concentrates | 35.70 | 12.70 | 48.40 |
| Night shift: | | | |
| Heads | 1.40 | .46 | 1.86 |
| Tails | .35 | .45 | .80 |
| Concentrates | 43.05 | 9.94 | 52.99 |
| August 3, 1935: | | | |
| Day shift: | | | |
| Heads | 4.90 | 2.88 | 7.78 |
| Tails | 1.40 | 1.31 | 2.71 |
| Concentrates | 100.80 | 23.70 | 124.50 |
| Night shift: | | | |
| Heads | 6.30 | 1.66 | 7.96 |
| Tails | 1.05 | 1.22 | 2.27 |
| Concentrates | 56.70 | 14.82 | 71.52 |
| September 9, 1935: | | | |
| Concentrates | 27.30 | 17.57 | 44.87 |

The only activity on the Crown King group of claims at the present time is the driving of two adits, one from the north and the other from the south, to intersect ore at depths in the old Union claim. Four men are employed in each heading.

## Idle Mines in the Pine Grove District

### Springfield[16/]

The Springfield group of copper claims is about 2-1/2 miles west of Crown King. The principal rock is granodiorite. The Springfield shaft is 175 feet deep and connects with a 200-foot tunnel 80 feet below the collar. A small chimney of sulphides has yielded 2 carloads of ore containing 12 percent copper.

16/ Lindgren, work cited, pp. 165-166.



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## Wildflower[17]

The Wildflower group comprises 13 patented claims. The mine is 3,000 feet east of Towers Mountain at an altitude of 6,800 feet. The country rock is much mixed and is sericitized. A fissure vein with quartz-sulphide filling has been exposed for 4,400 feet. The development consists of a 700-foot inclined shaft with levels at 110, 200, 300, and 480 feet. The ore body has been stoped to an average width of 5 feet. The mine was worked from 1917 to 1919 and production amounted to $104,000. About 13,000 tons of ore were milled, averaging $9 a ton. There are two ore shoots; the larger one yielded ore assaying $1.20 in gold, 6 ounces of silver to the ton, 2-1/2 percent copper, and 12 percent zinc.

## Del Pasco[18]

The Del Pasco vein is about 4,000 feet east of the Wildflower at an altitude of 6,300 feet. It is mentioned in Raymond's report of 1874. Here several tunnels have followed veins of quartz containing some sulphides and a little gold and silver.

## Philadelphia[19]

The property of the Philadelphia Mining Co. includes a number of claims covering the Nelson and Gladiator veins. Both veins are traceable for considerable distances and have been developed by shafts and tunnels.

## Fairview[20]

The Fairview vein, considered to be an extension of the Nelson, lies high on a ridge 2 miles north of Crown King. The country rock is generally a black clay slate. Tunnels on the property have disclosed sulphides and oxidized vein matter in quartz. A carload of ore was reported to be worth $30 a ton; most of the value was in gold.

## Lincoln[21]

The main workings on the Lincoln vein are 2 miles north-northeast of Crown King at an altitude of about 7,000 feet. The mine was worked in 1902 and from 1905 to 1908 and 10,000 tons of ore are said to have produced $135,000 net. The vein is contained in Yavapai schist. The ore consists of sulphides in a gangue of quartz and ankerite; it is reported to average 5 to 6 feet in width.

The property is developed by a shaft and several tunnels. A 15-stamp mill with plates and concentrating tables provided for the reduction of the ore. The concentrates contained 1 to 4 ounces of gold and 10 to 24 ounces of silver to the ton, and 15 percent copper.

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17/ Lindgren, work cited, pp. 166-167.
18/ Lindgren, work cited, pp. 167-168.
19/ Lindgren, work cited, p. 169.
20/ Lindgren, work cited, p. 170.
21/ Lindgren, work cited, pp. 170-171.



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## TIGER DISTRICT[22/]

The Tiger district adjoins the Pine Grove district on the south. The northern part is occupied by the granodiorite of the Crown King district, and at the south end this rock borders with intrusive contact against Bradshaw granite and an intercalated belt of Yavapai schist.

The veins form in general the southerly extension of the Crown King fissure deposits. The most westerly is the Standard group. Next east is the Tiger vein, which may be the extension of the Crown King system. East of this is the Oro Belle system. The deposits yield predominantly silver ores. Table 7 shows the production of the Tiger district by mines.

### Oro Belle and Gray Eagle

The Oro Belle and Gray Eagle is 4½ miles by road south of Crown King on the southern slope of Wasson Peak.

TABLE 7. - Production of Tiger District by Mines[1/]

| | Copper, pounds | Lead, pounds | Gold, value | Silver, value | Total value |
|---|---|---|---|---|---|
| Tiger | 200,000 | ..... | $ 50,000 | $ 700,000 | $ 780,000 |
| Oro Belle-Gray Eagle | ..... | ..... | 640,000 | 60,000 | 700,000 |
| Lukes (Gradbury) | ..... | ..... | ..... | 200,000 | 200,000 |
| Cougar (Bond) | ..... | 100,000 | ..... | 95,000 | 100,000 |
| Total | 200,000 | 100,000 | 690,000 | 1,055,000 | 1,780,000 |

1/ Elsing, M. J., and Heineman, R. S., Arizona Metal Production: Arizona Bureau of Mines Bull. 140, 1936, p. 102.

According to Lindgren[23/], the mine was worked between 1900 and 1912. The total production is estimated at $700,000. Weed, in the Mines Handbook, gives the following partial figures of production:

Gold, silver, and copper produced at the Oro Belle and Gray Eagle mine, 1907-9

| | 1907 | 1908 | 1909 |
|---|---|---|---|
| Gold, fine ounces | 4,313 | 123 | 1,226 |
| Silver, do | 9,937 | 3,639 | 2,725 |
| Copper, pounds | 19,010 | ..... | 4,820 |

Some work was done, it is said, in 1915 and 1916.

22/ Lindgren, work cited, p. 172.

23/ Work cited, pp. 174-175.



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The Oro Belle veins are developed by eight tunnels, of which the longest extends 1,000 feet. The Gray Eagle vein is opened by a shaft 600 feet deep. It is said to be from 2 to 15 feet wide and the ore is reported to have assayed $20 in gold and 2 ounces of silver to the ton and 1 percent copper.

The country rock is in large part sedimentary schist. In several places the schist is intruded by fine-grained granite dikes. The Oro Belle vein is said to be small and was worked mainly by lessees through the several tunnels. Nothing has been shipped from this property since 1916, but five men are at present engaged in driving underground workings to intersect an expected extension of an ore shoot indicated by a study of the maps.

## Idle Mines in the Tiger District

### Tiger[24/]

The Tiger mine is 2 miles south-southwest of Crown King. The property comprises 9 patented and 10 unpatented claims and is mentioned in the early Mint reports and in Raymond's reports. The total production, mostly in silver, is estimated at $750,000. In 1918 the tailings were reworked and yielded about $59,293. The heads are said to have assayed 13 ounces of silver to the ton, and the concentrates obtained averaged $150 a ton. The last work done in the mine was in 1910 and 1911. During this period 440 tons were shipped, yielded $40,700 net. About 13,000 tons were milled and averaged 0.07 ounce of gold and 22 ounces of silver to the ton.

The country rock is granodiorite. The principal vein is a composite quartz lode 20 feet wide. The ore, which was several feet in width, is mainly quartz with finely disseminated pyrite. The mine is developed by a vertical shaft 750 feet deep. Drifts extend along the vein several hundred feet on each side of the shaft.

## BIGBUG DISTRICT[25/]

The Bigbug district, one of the oldest in the region, lies on the northeast slopes of the Bradshaw Mountains, extending from Bigbug Mesa down to the foothills of the Agua Fria valley. The altitude ranges from 4,500 to 7,000 feet.

The predominating formation is Yavapai schist with numerous interbedded quartzite lenses. There are also many dikes of rhyolite porphyry with which certain of the deposits appear to be genetically connected.

The ore deposits belong to five classes: (1) Pyritic copper deposits in schists are represented by the Blue Bell, Hackberry, Butternut, Boggs, and other mines. (2) Pre-Cambrian quartz veins are represented by the old Mesa mine near Poland and probably by several veins near McCabe. (3) A gold-silver replacement deposit, the Iron King, near Humboldt is of an unusual type. (4) Veins of later date, probably connected with the rhyolite dikes, are best exposed in the vicinity of Poland and Providence. The rich silver deposits with barite and calcite gangue about 2 miles west of the Humboldt smelter also belong to this group. (5) Placers have been worked in several gulches near McCabe.

Table 8 shows the amount and value of the metal production of the Bigbug district from 1901 to 1933. Table 9 shows the production of the district by mines.

24/ Lindgren, work cited, p. 172.
25/ Lindgren, work cited, pp. 126-127.



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TABLE 8. - Production of Bigbug District, Yavapai County[1/] 1901-1933

| Year | Producers | | Tons | Gold value | Silver, ounces | Copper, pounds | Lead, pounds | Zinc, pounds | Total value |
|---|---|---|---|---|---|---|---|---|---|
| | Lode | Placer | | | | | | | |
| 1901 | .... | ..... | 11,580 | $ 236,548 | 58,533 | 70,000 | 285,000 | ..... | $ 295,613 |
| 1902 | .... | ..... | 13,425 | 249,013 | 53,135 | 103,597 | 391,000 | ..... | 304,886 |
| 1903 | .... | ..... | 16,038 | 187,494 | 94,877 | 155,833 | 732,359 | ..... | 292,072 |
| 1904 | .... | ..... | 23,939 | 409,067 | 129,578 | 86,934 | 139,380 | ..... | 479,361 |
| 1905 | .... | ..... | 20,431 | 234,894 | 99,336 | 210,423 | 384,880 | ..... | 346,514 |
| 1906 | .... | ..... | 60,349 | 445,384 | 195,257 | 992,209 | 574,403 | ..... | 800,443 |
| 1907 | .... | ..... | 68,577 | 398,260 | 193,380 | 1,399,127 | 443,182 | 140,786 | 837,510 |
| 1908 | .... | ..... | 13,429 | 161,271 | 41,152 | 22,634 | 292,383 | ..... | 198,349 |
| 1909 | .... | ..... | 17,888 | 284,375 | 72,495 | 319,816 | 337,184 | ..... | 378,148 |
| 1910 | 20 | 6 | 37,937 | 106,696 | 58,296 | 2,069,919 | 119,611 | ..... | 406,324 |
| 1911 | 23 | 8 | 42,338 | 81,168 | 63,423 | 2,733,644 | 67,106 | 8,913 | 460,014 |
| 1912 | 21 | 5 | 23,480 | 40,638 | 40,639 | 1,216,074 | 27,086 | 54,343 | 260,394 |
| 1913 | 20 | 3 | 38,817 | 30,943 | 37,965 | 2,010,633 | 17,296 | ..... | 366,283 |
| 1914 | 21 | 7 | 56,690 | 50,261 | 57,488 | 3,694,229 | 26,559 | ..... | 574,421 |
| 1915 | 18 | 3 | 83,598 | 53,154 | 80,467 | 4,285,668 | 78,170 | ..... | 847,616 |
| 1916 | 18 | ..... | 76,118 | 71,696 | 98,182 | 3,612,616 | 131,618 | 10,255 | 1,035,460 |
| 1917 | 18 | ..... | 109,736 | 146,400 | 191,870 | 6,774,730 | 256,194 | ..... | 2,176,035 |
| 1918 | 25 | 1 | 141,338 | 227,167 | 254,027 | 7,936,339 | 169,004 | ..... | 2,453,470 |
| 1919 | 10 | 1 | 127,437 | 137,955 | 197,448 | 5,716,132 | 206,656 | ..... | 1,433,252 |
| 1920 | 17 | ..... | 116,184 | 122,070 | 182,495 | 5,016,344 | 144,999 | ..... | 1,255,598 |
| 1921 | 5 | ..... | 1,607 | 3,318 | 23,134 | 981 | 102,226 | ..... | 31,178 |
| 1922 | 15 | 3 | 26,571 | 29,128 | 54,862 | 1,529,984 | 80,599 | ..... | 294,971 |
| 1923 | 12 | 3 | 85,062 | 57,834 | 148,238 | 4,874,836 | 207,357 | ..... | 910,505 |
| 1924 | 4 | ..... | 10,385 | 14,361 | 20,184 | 852,394 | 7,152 | ..... | 140,120 |
| 1925 | 10 | 4 | 21,883 | 53,414 | 50,945 | 793,342 | 45,831 | ..... | 205,412 |
| 1926 | 15 | 2 | 44,617 | 59,670 | 59,695 | 1,953,501 | 24,085 | ..... | 372,337 |
| 1927 | 11 | 1 | 2,997 | 13,252 | 8,883 | 179,335 | 3,480 | ..... | 42,000 |
| 1928 | 10 | 2 | 1,673 | 5,339 | 7,910 | 264,814 | 7,825 | ..... | 48,554 |
| 1929 | 8 | 3 | 2,322 | 4,587 | 20,788 | 159,938 | 60,175 | ..... | 47,607 |
| 1930 | 11 | 8 | 3,983 | 16,564 | 38,773 | 355,160 | 149,887 | ..... | 85,157 |
| 1931 | 12 | 7 | 1,122 | 12,933 | 3,185 | 10,478 | 9,220 | ..... | 15,151 |
| 1932 | 6 | 24 | 421 | 10,462 | 206 | 2,191 | ..... | ..... | 10,658 |
| 1933 | 6 | 6 | 1,772 | 33,373 | 1,923 | 2,266 | 19,595 | ..... | 34,916 |
| Total | .... | ..... | 1,303,664 | 3,988,689 | 2,638,769 | 59,406,091 | 5,481,502 | 214,297 | 17,440,329 |

1/ Elsing, M.J., and Heineman, R.S., Arizona Metal Production: Arizona Bureau of Mines Bull. 140, 1936, p. 81.



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TABLE 9. - Production of Bigbug District by Mines[1/]

| | Copper, pounds | Lead, pounds | Gold, value | Silver, value | Total value |
|---|---|---|---|---|---|
| Blue Bell, 1896-1926 | 56,000,000 | ..... | $1,000,000 | $1,200,000 | $14,000,000 |
| Lelan-Dividend, 1900-31 | 400,000 | 600,000 | 500,000 | 100,000 | 700,000 |
| Butternut | 1,200,000 | ..... | 60,000 | 10,000 | 225,000 |
| Henrietta (Big Bug) | ..... | ..... | 1,200,000 | 50,000 | 1,250,000 |
| McCabe-Gladstone, 1880-1926 | 1,200,000 | 500,000 | 2,200,000 | 600,000 | 3,000,000 |
| Little Jessie, 1867-1915 | ..... | ..... | 950,000 | 50,000 | 1,000,000 |
| Poland, 1900-12 | ..... | 1,000,000 | 300,000 | 400,000 | 750,000 |
| Silver Belt, 1870-80 | ..... | 1,000,000 | ..... | 300,000 | 350,000 |
| Iron King | 5,000 | ..... | 50,000 | 50,000 | 100,000 |
| Arizona National, 1921-26 | ..... | 1,000,000 | ..... | 60,000 | 115,000 |
| Union | ..... | ..... | 150,000 | ..... | 150,000 |
| Sterling, 1900-20 | ..... | ..... | 100,000 | ..... | 100,000 |
| Merchants Home | ..... | 400,000 | ..... | 50,000 | 70,000 |
| Mesa, 1900-10 | ..... | ..... | 40,000 | ..... | 40,000 |
| Pocahontas, 1906-21 | 100,000 | 150,000 | 8,000 | 20,000 | 50,000 |
| Hackberry (Boggs), 1930-31 | 100,000 | ..... | 5,000 | ..... | 20,000 |
| Total | 70,005,000 | 4,650,000 | 6,563,000 | 2,890,000 | 21,920,000 |

1/ Elsing, M.J., and Heineman, R.S., Arizona Metal Production: Arizona Bureau of Mines Bull. 140, 1936, p. 101.



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## McCabe-Gladstone

Three-quarters of a mile south of Humboldt a side road turns off to the west from the Black Canyon highway, and 3 miles farther on arrives at the old mining community of McCabe in the Bigbug mining district.

According to Wilson,[26] during the early seventies this deposit yielded considerable amounts of rich oxidized ore. It was worked continuously from 1898 to 1913 by the Ideal Leasing Co., who reported a production of $2,500,000 to $3,000,000. In June 1934 mine ore mixed with old gob and dump material was being treated in a flotation mill.

The mine is developed by two shafts 800 feet apart and 900 to 1,100 feet deep, together with several miles of workings.

Here, amphibolitic schist is intruded by dikes of rhyolite-porphyry and, a short distance farther southwest, by a stock of quartz diorite. The vein strikes N. 54° E. and dips 79° SE.; it averages about 3-1/2 feet wide. Stoping has followed five ore shoots, each 200 to 500 feet long. The ore consists of quartz together with considerable amounts of pyrite and arsenopyrite and a little sphalerite, galena, and chalcopyrite.

Lindgren[27] gives the following analysis of the average shipping ore from the McCabe-Gladstone mine: Silica, 31.4%; copper, 2.0%; lead, 2.1%; zinc, 4.7%; iron, 24.6%; arsenic, 3.9%; antimony, 1%; sulphur, 20.4%; gold, 1.6 ounces per ton; and silver, 10.2 ounces per ton.

The Harbud Mining Co. is now operating the old McCabe-Gladstone property, concentrating ore from underground workings and from the dumps in a 150-ton flotation mill. The manager, W. Forri, kindly cooperated in compiling the data that follow:

### Mines

The present underground workings at the Gladstone mine are reached by a small shaft that has been sunk to a depth of 120 feet; two miners are drifting west from the bottom with hand steel. The shaft follows the Gladstone vein down at a dip of 80°. A gasoline hoist raises the ore in a 500-pound bucket.

The old Gladstone dump is being removed by a 3/8-cubic yard tractor shovel loading into 3-1/2-ton trucks, which haul the material about 1,500 feet to the mill. The shovel was installed recently to continue the excavating begun by a tumblebug scraper pulled by a tractor, which discharged its load through an opening in an elevated platform into trucks below. Large pieces of waste are thrown to one side.

At the McCabe mine the old main shaft, following the dip of the ore at about 75° is being used. The vein, paralleling that at the Gladstone mine and ranging in width from 2 to 5 feet, is being mined above the 400-foot level. About 50 tons a day are hoisted in a 1,350-pound bucket, using one side of the old double-drum hoist. A 75-horsepower motor operates the hoist, which is equipped

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26/ Work cited, pp. 36-37.
27/ Work cited, p. 132.



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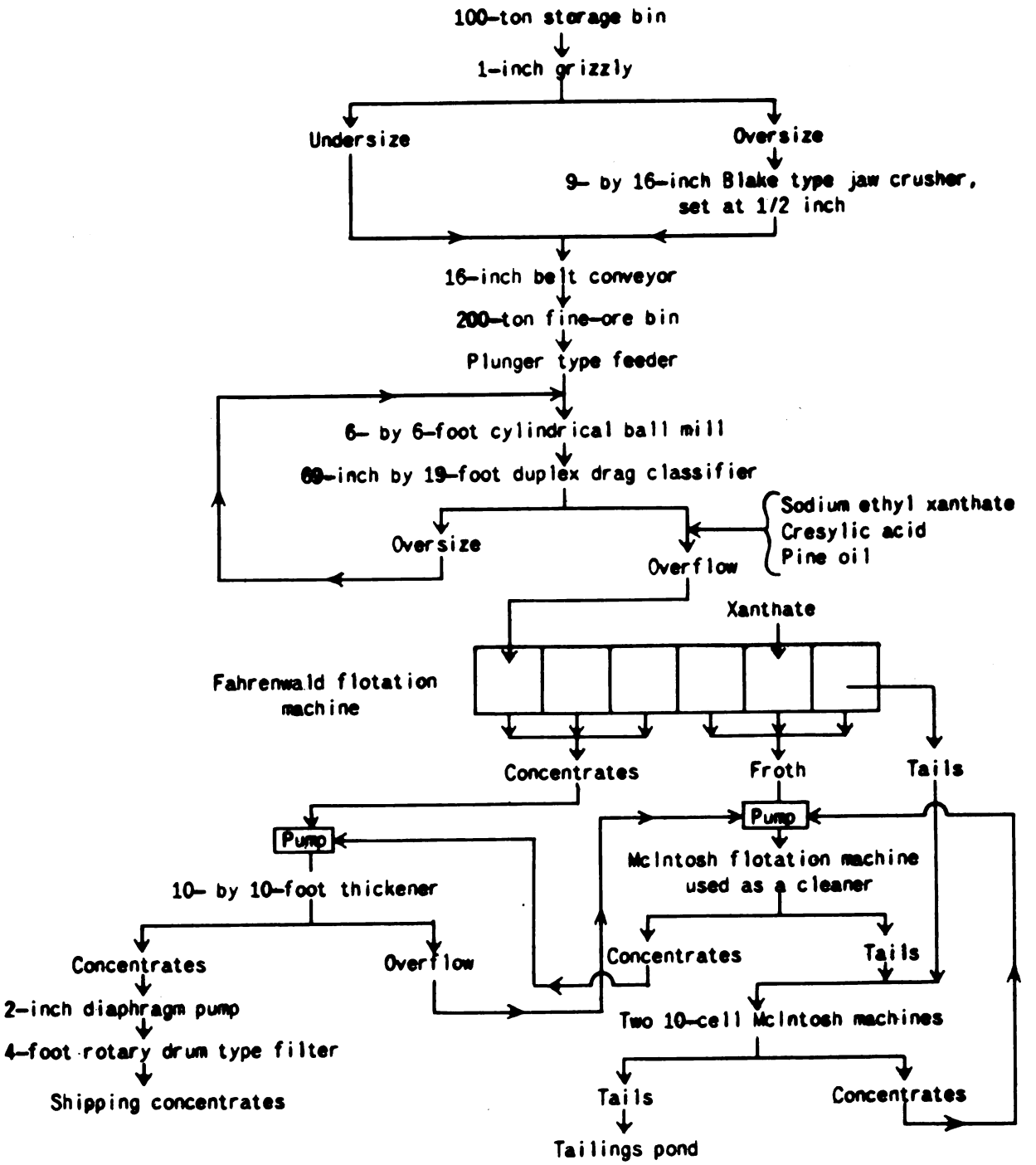


Figure 9.- Flow sheet of the McCabe-Gladstone mill.

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with a 1-inch steel-wire rope. The bucket dumps automatically into a hopper, from which trucks haul the ore to the mill. A 12- by 10-inch compressor, belt driven by a 50-horsepower motor, supplies air to the five drills that are used underground. The drill steel is sharpened by hand. A 9 stage, 75-horsepower pump on the 500-foot level pumps about 150,000 gallons of water per day to a 1,000,000-gallon concrete storage tank on the surface. Total power utilized at the property amounts to about 100,000 kw.-hr. per month. A force of about 16 men is employed at the mine, all work being done on the day shift.

A slusher has been operating on the old McCabe dump, loading trucks through a hole in an elevated platform. It is planned to remove the remaining 10,000 tons of this dump with the shovel now excavating the Gladstone dump.

The sources of the ore that constituted the mill heads for 1935 were approximately as follows:

| | Tons per day |
|---|---|
| McCabe mine | 45 |
| Gladstone mine | 10 |
| McCabe dump | 45 |
| Gladstone dump | 50 |
| Total mill heads | 150 |

A similar distribution is contemplated for 1936.

## Mill

All the mill ore is dumped from trucks into a 100-ton storage bin at the head of the mill (fig. 9). It then passes over a 1-inch grizzly to a 9- by 16-inch Blake-type jaw crusher set at 1/2 inch. The crushed product and the undersize from the grizzly are carried by a 16-inch belt conveyor a distance of 60 feet and discharged into a 200-ton fine-ore bin. A plunger-type feeder at the bottom of the bin delivers the ore to a 6- by 6-foot cylindrical ball mill using 4-inch cast-iron balls. In closed circuit with the ball mill is a 69-inch by 19-foot duplex drag classifier, into the overflow of which are fed the flotation reagents. The mixture of reagents now being used contains 0.3 pound of sodium ethyl xanthate, 0.25 pound of cresylic acid, and 0.03 pound of pine oil per ton of ore. The classifier overflow, 70 to 75 percent of which is minus 100 mesh, passes into the first cell of a 6-cell Fahrenwald flotation machine. The first three cells make a concentrate that is pumped into a 10- by 10-foot thickener. Additional xanthate is added to the fifth cell. The froth from the last three cells is pumped with the overflow from the thickener to a McIntosh flotation machine, which is used as a cleaner and which delivers a concentrate to the above-mentioned thickener. The tails from the Fahrenwald machine and from the McIntosh cleaner pass to two 10-cell McIntosh machines, the concentrate from which is pumped to the McIntosh cleaner and the tails from which are run out to the tailings pond.

The product from the thickener is delivered by a 2-inch diaphragm pump to a 4-foot rotary drum type filter, which makes the shipping concentrate. The mill consumes 200,000 gallons of water per day, and much effort is being expended in building up the settling capacity of the tailings pond to produce a clear overflow.



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The ratio of concentration of the mill is about 20 to 1, and the recovery is about 80 percent. The average grade of the mill heads is 0.13 ounce of gold per ton and the tails carry away 0.027 ounce per ton.

During 1935 the mill produced 2,500 tons of concentrates containing an average of 1.98 ounces of gold and 3.9 ounces of silver per ton. Total metals paid for during that year amounted to 5,073 ounces of gold, 10,700 ounces of silver, and 24,500 pounds of copper. The concentrates take the Hayden freight rate of $4.50 per ton to El Paso.

## Lelan-Dividend[28]

The Lelan mine is on a ridge on the south side of Chaparral Gulch. This deposit was discovered during the sixties. Browne's report for 1868 states that 60 tons of ore from the Dividend mine treated in the Big Bug (Henrietta) mill yielded $20 per ton in free gold. At that time, however, it was not of commercial grade. According to Lindgren[29] the Lelan and Dividend were worked intermittently from 1900 to 1914. He states that their ore production prior to 1923 was probably at least 10,000 tons, which contained from 1/2 to 3 ounces of gold per ton together with a little silver, copper, and lead.

In 1932 and 1933 the property was operated by the Southern Exploration Co. with a force of about 25 men. This company erected a 100-ton flotation-concentration plant and produced concentrates during part of 1933. Operations were suspended at the end of the year.

The vein is a continuation of the Union. It is opened by a 500-foot shaft inclined at 80°, with development on five levels. The ore consists of disseminated sulphides carrying gold in a quartz gangue.

When the property was visited in March 1936 lessees were mining ore that the old-timers left on the 400-foot level of the Lelan mine. Three men are extracting about 1 ton a day. Their surface equipment consists of a gasoline hoist and compressor, and underground they operate two air drills, a plugger, and a stoper. The ore is being hoisted out of the old shaft. On February 18, 1936, a shipment of 33 tons of ore was made to the smelter at Clarkdale. The trucking cost was $4.50 per ton and a smelter treatment charge of $4 per ton is expected. Albert Adams, one of the partners, estimates that the shipment will assay about 1 ounce of gold and 2 to 2-1/2 ounces of silver per ton.

## Henrietta or Big Bug[30]

The Henrietta mine, formerly known as the Big Bug, is about 1/2 mile north of Bigbug Creek and 1 mile west of Poland siding. Browne's report for 1868 states that in 1866 the Big Bug mine was some 50 feet deep and was producing ore from near the surface. In 1871, according to Raymond, the Big Bug vein was not being worked but the 10-stamp mill was treating gold ores from the vicinity.

In 1883 and 1884 the property was the most prominent in the district. From 1915 to 1919 gold-bearing copper ore was taken from below the old workings. The

28/ Wilson, work cited, p. 38.
29/ Work cited, p. 133.
30/ Wilson, work cited, p. 39.



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property was equipped with a 100-ton flotation mill. Additional shipments of ore were made in 1926 and 1930. Old development workings include a 500-foot shaft and a 1,500-foot tunnel through the ridge 220 feet below the collar. Later workings consist of a 2,200-foot tunnel and a 600-foot winze with levels and stopes extending a few hundred feet. The vein is from 2 to 6 feet wide and contains sulphides in a gangue of quartz. Ore from the lower levels is reported to contain 3.2 percent copper and 0.2 ounce of gold and 2.7 ounces of silver per ton. In March 1936 three miners were extracting about 1 ton a day from the old workings.

## Idle Mines in the Bigbug District

### Union[31]

The Union mine was in active operation in 1922. It is claimed that the Little Jessie and Union properties when consolidated had a total production of $800,000. The present workings are in the upper part of Chaparral Gulch at an altitude of about 5,000 feet.

At the Union mine the principal rock is sheared Bradshaw granite. The property is developed by a 1,200-foot tunnel that penetrates the ridge. The Union vein is the northeast continuation of the Lelan vein. A shaft has been sunk from the tunnel level at a point 500 feet west of the crosscut to a depth of 200 feet, but so far only one level 77 feet below the tunnel has been opened from this shaft.

The vein strikes about N. 70° E. and dips steeply southeast. The ore consists mainly of quartz as much as 10 feet thick, with irregularly disseminated pyrite, arsenopyrite, sphalerite, and galena. The gold is not free except in the oxidized zone. On the tunnel level and on the 77-foot level the oreshoot is cut and is said to be 250 feet long; ore has been found also in the northeast face of the 77-foot level.

### Little Jessie[32]

The Little Jessie mine is about 1,700 feet south of the Union. The deposit was discovered in 1867. From about 1890 to the end of 1898 it was worked by J. S. Jones and lessees. From about 1909 to 1916 considerable development work was done, and a little ore was shipped, mainly by the Chaparral Mining Co. Early in 1934 the Arizona Consolidated Mining Co. was reported to be carrying on development work and installing new mill machinery at the Union-Jessie property.

Lindgren[33] states that in 1922 the shaft was 659 feet deep and that much high-grade auriferous pyrite was encountered between the 500- and 600-foot levels. He adds that the ore contains 1/2 to 1 ounce of gold per ton and very little silver.

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31/ Lindgren, work cited, pp. 133-134.
32/ Wilson, work cited, p. 38.
33/ Work cited, p. 132-133.



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## Poland-Walker Tunnel[34]

Poland, at the northern foot of Bigbug Mesa, is accessible by road from the Black Canyon highway. The tunnel extends northward for 1,100 feet through a ridge of granite. It exposed several quartz veins upon which considerable work has been done.

The Poland vein was cut 800 feet from the south portal. According to local reports the vein was opened by several thousand feet of drifts and a 325-foot shaft below the tunnel level. From 1900 until about 1912 intermittent production was made with a 20-stamp mill. The 1907 yield was $130,465 in gold and 16,609 ounces of silver. The total output of this period is estimated at $750,000, probably mostly in silver. According to the U. S. Mineral Resources the mine produced a small amount of gold ore in 1926, 1930, and 1931. Early in 1934 occasional shipments of gold-bearing ore and concentrates were made.

## Money Metals[35]

The Money Metals mine is about 1-1/4 miles west of the Poland tunnel. This deposit was located in 1897 by F. Reif, who shipped some ore from the upper levels. After some further development work the mine remained idle until 1928, when it was reopened. Since 1933 it has been operated intermittently by the Yavapai Gold and Silver Mining Co. Workings on the property include a 300-foot shaft and approximately 1,400 feet of drifts on three levels.

The country rock is gneissoid granite. The vein filling consists of quartz with irregular disseminations of sulphides. On the 200-foot level, the ore shoot is about 175 feet long by 2 to 5 feet wide. According to J. K. Kilfeder, mine superintendent, much of the vein contains about half an ounce of gold per ton. The sulphide concentrates are reported to carry more than $200 in gold per ton.

## Iron Queen[36]

The Iron Queen mine on the south side of Boggs Flat has been idle for many years. The shaft is 300 feet deep. The country rock is rusty schist impregnated with pyrite. The ore minerals are pyrite, chalcopyrite, sphalerite, and a little galena and specularite. The ore was of low grade, containing 2 to 2-3/4 percent copper, 38 percent iron, 50 cents in gold, and 1 ounce of silver to the ton. It was used mainly as a flux for richer ore.

## Blue Bell[37]

The Blue Bell mine is 4 miles south of Mayer at an altitude of 4,500 feet. It has modern, electrically driven equipment and is connected with the railroad siding by an aerial tram 1 mile long. After 1906 the mine developed into the largest producer in the Bradshaw Mountains. The deposit is contained in the Yavapai schist.

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34/ Wilson, work cited, pp. 39-40.
35/ Wilson, work cited, p. 40.
36/ Lindgren, work cited, p. 140.
37/ Lindgren, work cited, pp. 143-145.



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The ore body is essentially a silicified and mineralized zone that conforms to the schist. The width is about 100 feet. The ores form a series of about six flat lenses within the zone. The lenses are as much as 40 feet wide and average 3 percent copper. The ore minerals are mainly pyrite and chalcopyrite; quartz is the principal gangue mineral.

Development consists of a vertical shaft 1,400 feet deep with almost 30,000 feet of levels. There are five smaller shafts. The stopes stand well; some of them are 80 feet high and 20 feet wide. The fourteenth level was opened in 1922. The developed length of the deposit is 1,600 feet.

### Iron King[38/]

The Iron King mine is a little more than 1 mile west of the Humboldt smelter. The deposit, which carries gold and silver, forms a replacement zone in the Yavapai schist. It was worked about 1906 and 1907. The production in 1907 was 1,253 ounces of gold, 35,491 ounces of silver, and 3,933 pounds of copper.

The deposit is developed by two shafts 750 feet apart; one is 435 feet deep and the other is 225 feet deep. The ore is reported to contain from $6 to $8 in gold and from 4 to 23 ounces of silver to the ton.

The deposit forms a series of lenses in highly silicified schist. These lenses are 150 to 500 feet long and 5 to 10 feet wide. The entire mineralized zone is 75 feet wide. The ore consists of streaks of fine-grained sulphides in schist.

## SUMMARY

Favorable market prices for gold and silver have revived mining activity in the Black Canyon area. Gold is the principal metal produced at all the mines except the Swastika, which is a silver mine. Some silver occurs with the gold at all properties except the Richinbar. Most of the concentrates contain base metals. An appreciable revenue is derived from the lead content of the concentrates from the Golden Turkey and Golden Belt mines. The concentrates made at the Thunderbolt mine contain sufficient zinc to be shipped for that metal, but the lead and silver content makes it more profitable to ship to a lead smelter and pay a penalty for the zinc. The concentrates from the McCabe, Golden Belt, and Golden Turkey mines and the ore from the Silver Cord mine contain about 0.5 percent copper.

The Golden Belt and the Golden Turkey mines, both on the same vein, are the only ones that maintained a steady production during 1935.

Relatively thin veins of ore and ground that stands well have confined mining methods to open stopes in all but the Swastika mine, where a cut-and-fill method has been employed.

All mills in the district are of the flotation type, and a comparison of the flow sheets shows great uniformity in the method of treatment.

The equable climate makes labor available at moderate wages. A power line through the district and nearby markets for supplies contribute to low costs of operation. Transportation costs are high whether shipping is done by railroad or truck. Smelter contracts are fairly uniform. Operators in the district feel encouraged by the results of present operations and look forward to a year of greater activity.

38/ Lindgren, work cited, pp. 127-128.



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